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CONTENTS.

	PAGE.
Colonial Veterinary Service	125
Rubber in 1928	126
Cacao Research	127
North Borneo Tobacco Culture	133
South African Maize	134
Gumming Disease of Sugar-Cane	135
Colonial Appointments	138
Vitamins (*Continued*)	138
Mauritius Dried Litchis	140
Sierra Leone Grasses	141
The Principal's Report, 1927-28	144
The International Institute	147
Correspondence	147
Tropical World Notes	148
Reviews	149
Science Progress	149
Books Received	150
Chemical Notes	151
Sugar Notes	152
Sports	153
Acknowledgment	153
College News	154
Agricultural Excursion	154
Mr. F. L. Engledow's Visit	155
West Indian Sugar Industry	155
Obituary	155
Colwyn Gold Medal	155
Coffee in 1928	155
Trend of the Markets	156

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COLONIAL VETERINARY SERVICE.

IN July, 1927, the Colonial Secretary convened a Committee under the Chairmanship of Lord Lovat to frame proposals for obtaining the highest degree of efficiency in regard to Veterinary Research and Administration in the non-self-governing dependencies.

The report* of this Committee, which has now been issued, emphasizes the importance of veterinary activities in the well-being of the Colonial Empire. The development of a successful Public Health Service involves problems, not only of milk and meat supplies, but in the prevention of insect-borne diseases. The advance of agriculture, the staple industry of most of the colonies, is closely associated with animal husbandry in its widest sense—in the use of stock for agricultural operations, transport, manure and so on, and in the growth of fodder crops. Moreover, the importance of industries of animal origin is considerable and is capable of becoming greater in many colonies.

The Committee considers that in the past too narrow a conception has been taken of Veterinary Science which should include all matters relating to the preservation of the domestic animal in the normal state as well as when sick. Accordingly it is recommended that the existing title of "Veterinary Department" should be replaced by that of "Department of Animal Health."

The problems of animal industry in the tropics have not yet received the same attention as they have in temperate zones, and the adequate study of these problems—which include many not even realised by people at home—requires men of a high scientific type and with a special training. To attract that correct type several important recommendations are put forward; and to make service in the Colonial Departments of Animal Health sufficiently attractive in pay and prospects an initial salary of £600 per annum is considered adequate but the existing maxima should be increased to £3,000. It is realised, of course, that relatively few will reach the maximum, but it is such that it should attract veterinarians of the highest ability. In order to avoid the anomaly that the poorest colonies should have the poorest service it is recommended that a unified Colonial Veterinary Service should be established. To feed this Service a temporary system of Scholarships is

*Colonial Veterinary Service, Report of a Committee appointed by the Secretary of State for the Colonies. Cmd. 3261.

proposed in order to allow graduates in science to become veterinary surgeons and veterinary surgeons to become graduates of science. Young officers would, on appointment undergo a six months course of instruction at a Tropical Veterinary School at home and tropical research would be kept up-to-date by a Central Research Institute abroad. To co-ordinate all these departments an Adviser in Animal Health would be appointed at the Colonial Office and he would be assisted by a strong representative committee. These recommendations are far-reaching, but their benefits to the Colonies would be enormous. An excellent grade of workers would be attracted to the Services and all classes of Colony would benefit alike.

In the smaller colonies at present the keen young worker is often side-tracked for life with the smallest prospects of promotion or transfer. Consequently their Animal Health Departments are often inadequately staffed. Under the new scheme, junior officers would receive their initial field experience in one of the larger departments. The needs of the smaller colonies would be met by posting of officers to them who would be now fitted to take his place as sole representative of the Animal Health Department. The smaller colonies would now actually attract the keen worker as they offer experiences in administration and organisation on a smaller scale than in the larger organisations, experiences only available to the senior officers in the large colonies. As he grows older, the young officer now with his training both in field and in administrative work, would be eligible for senior appointments elsewhere. The small colony would benefit by securing the the services of a worker properly trained in field work, the large by one with administrative experience.

The smaller colonies often offer such an inadequate salary—sometimes as low as £375 per year—that the greatest difficulties in recruitment are experienced. The Committee is convinced that these difficulties will increase unless larger salaries are available. In a Department staffed by a single officer of the unified Service, the salary would probably amount to about £700 per year, but the excess over the usual salary paid would be more than compensated for by the officer's ability, training and experience and the reliance which the Colonial Government could place in him. Moreover, this single Service would provide reinforcements of the highest scientific ability in the event of outbreak of animal disease not hitherto experienced.

Of recent years the British Empire has done much for tropical medicine, tropical agriculture and tropical forestry, but as yet but little for tropical veterinary science. The importance of the problems of animal health in the colonies is such, however, that it can no longer leave them unsolved.

RUBBER IN 1928.

In their annual Review, Messrs. Symington and Sinclair report that owing to the removal of the restriction scheme by the British Government, the Rubber Market in 1928 passed through its most difficult and trying period. The year began with the price of Ribbed Smoked Sheet on the Spot at 1*s.* 8*d.* and with a slow market declined on 2nd February, to 1*s.* 5⅜*d.*, recovering abruptly to 1*s.* 6⅛*d.* on 3rd February, and finally closing at 1*s.* 6*d.* on 8th February. From 8th February, the date of the Prime Minister's announcement to 4th April, when the Government definitely announced that restriction would cease at the end of October, prices fluctuated between 1*s.* 4½*d.* and 1*s.*, dipping for a period of three days to 11*d.* Immediately the announcement was made, values fell about 2*d.* and continued to drop till Spot reached the low point of 7¾*d.* on 8th April. The price then recovered to 9¾*d.* towards the end of May and after remaining over 9*d.* till the end of August finally closed at 8½*d.* on 10th September, the level at about which it remained till the end of the year.

The world's consumption of rubber for 1928 was originally estimated at 625,000 tons but on account of the low prices brought about by the abolition of restriction it was exceeded by 59,000 tons (America accounting for 51,000 tons of the increase). America consumed 441,500 tons or 64¾ per cent. of the world's consumption against a proportion of 64 per cent. for 1927, 67¼ per cent. for 1926 and an average of 70 per cent. for the seven years ending 1925.

With regard to production there are no very reliable data for making correct estimates of the potential unrestricted output of Malaya or for judging the effect of lower prices on the world's total output, or of the effect on consumption of a price ruling somewhere in the neighbourhood of 1*s.* That it will, to a certain extent knock out the use of reclaimed rubber and stimulate new uses is fairly evident but it is difficult to attempt any estimate in tons of the extra quantity of raw rubber which will be required.

Summarised estimates for consumption and production for 1928 and 1929 work out as follows:—

	Consumption.		
	1928. Tons.	**1929.** Tons.	**Increase.** Per cent.
U. S. A.	441,500	460,000	4½
The Rest	242,500	263,000	8½
Total	684,000	723,000	5¾

	Production.		
	1928. Tons.	**1929.** Tons.	**Increase.** Per cent.
Malaya	297,500	350,000	17
Dutch East Indies	226,000	240,000	6¼
The Rest	100,000	136,000	36
	623,500	726,000	16½

G. G.

CACAO RESEARCH.

Results of Cacao Research at River Estate, Trinidad.

BY W. G. FREEMAN, B.SC., A.R.C.S.,
Director of Agriculture, Trinidad and Tobago.

THE Department of Agriculture of Trinidad and Tobago has, for close upon twenty years, been engaged on research into some of the fundamental problems of cacao cultivation. The object of this paper is to give a brief summary of the work and of the results.

Conditions of Work.

In the first place it is desirable to give some account of the conditions under which the work has been done. The Department has been fortunate in having had, under its charge, River Estate, a property of some 1,500 acres in area of which about 500 acres are now in cacao. It has thus been possible to experiment on an estate scale and under estate conditions. River Estate was not originally intended to be a cacao experiment station or even a model cacao estate. It was purchased for £4,629 by the Government, in 1897, in order to secure the water rights for a pumping station to supply Port-of-Spain. It was then practically an abandoned sugar estate with a small portion in cacao. The Government leased it out, but resumed possession in 1904, paying £1,300 for the surrender of the lease, and charge of the property was entrusted to the old Botanical Department. The cacao crop then was 182 bags.* The cultivation was extended under the "contract" system. Men of the labouring class are allotted a few acres each, on which they plant cacao, shade trees, and the usual food crops—bananas, cassava, tannias (*Xanthosoma*) which serve as temporary shade for the young cacao. They live on the produce of these minor crops, supplemented often by earnings as labourers on the estate, and when the cacao trees come into bearing the owner takes over the contract paying at a fixed rate (about one shilling) per bearing tree, and less for younger trees. The owner avoids much capital outlay until there is a crop to be reaped, but the results are not always satisfactory and at River much work has had to be done in bringing bad contracts up to a reasonable standard.

Towards the end of 1908 the present Department of Agriculture, in which the old Botanical Department was merged, was created, and River Estate came under its charge. Until 1920 the estate continued to be worked on an advance account, but in that year its finances were included in the ordinary Department estimates. It has been developed to yielding a cacao crop of 1,319 bags in 1927, the record year. In addition some 500 acres have been re-afforested in valuable timber, 35 acres established in grape fruit and oranges (one to six years), 30 in coffee, 12 in other permanent economic crops. Much attention has also been given to providing better dwellings for labourers, extending estate roads, &c. Interest was not charged on the original advances, but by 1915 the estate had repaid to the Government the capital expenditure, and to date has paid into the Treasury some £2,000 more than it has drawn. The value of the property may now be put at about £35,000, the cost of development having been defrayed by its own earnings.

*A Trinidad bag of cacao is 165 lb. The local unit of measurement is the old Spanish hundredweight, the fanega, 110 lb. and a bag contains one and a half fanegas.

First Experiments.

In 1910 a set of manurial experiments was laid out on then conventional lines. Plots of 50 trees each, were demarcated in a field of apparently uniform cacao, and manured in various ways, three plots being left as controls. The results as regards manurial treatment need not be discussed now. They are given in a series of reports by J. de Verteuil, then Superintendent of Field Experiments, in the *Bulletin* of the Department from 1912 to 1917. It was soon obvious that the manure applied was a very minor factor in determining the yield of a plot and this unexpected result diverted attention very early to the study of the cacao tree itself. In following up this line of work the Department entered upon a piece of long range research, to use the popular modern term, which has yielded valuable fundamental results and furnished the cacao planter both here and in other countries with a practical means of economically increasing his production.

The Bearing Capacity of Trees.

Seeking to find the cause of the unexpected result referred to above, a large number of trees in various fields at River, and on eight other estates in the Colony were labelled and records kept to determine the *natural* yield of plots and individual trees, all unmanured, and under similar cultural treatment in each field. The results were summarized by de Verteuil in a "Report on Estate Experiments, 1910-17."(1) The more important points which were established were the following :—

That the variation in the yields of various plots was due to the relative productiveness of the trees in each plot, and largely dependent on the relative proportion of heavy and poor bearing trees in each plot. That a large proportion of the trees give less than 13 pods (about 1 lb. of cacao) per annum even in a very favourable year. That other trees are heavy bearers, and that generally speaking heavy bearing trees continue to be heavy bearers, and poor bearing trees continue to be poor bearers.

The task of keeping individual yields was persevered with on a large scale, and records obtained at River for some 14,000 trees over a period of ten years.

In a paper by the writer in 1919 on "Recent Experimental Work on Cacao"(2) detailed figures were given to justify the conclusion that cacao trees can be grouped into heavy, medium and poor bearers, and that generally speaking they maintain these characteristics year after year. Some of the poor bearers are obviously weak or retarded trees, but others are equally as strong and vigorous as the good bearers. Moreover, special cultural and manurial treatment does not produce any fundamental change.

The following records of seven trees in a plot at River, manured for each of seven successive years with a "complete" manure will serve to illustrate this point :—

Pods per annum per tree. 1911-12 *to* 1918-19.

Tree								
A ..	63	102	81	93	100	135	67	106
B ..	91	125	123	206	129	191	60	123
C ..	51	50	44	48	78	45	55	41
D ..	46	41	44	43	32	32	36	44
E ..	23	45	33	31	26	26	17	26
F ..	3	6	3	7	5	25	3	21
G ..	1	6	26	22	30	12	5	19

There is on the whole an increase in bearing capacity with increase in age, but the poor trees F and G of the two first years are still the poor trees of the last two years, and similarly with the heavy bearers A and B and the medium bearers C, D and E.

Concurrently with these investigations, data were collected to determine the proportion of poor bearers which normally occurred on cacao estates in the Colony. In a report for 1913-14, de Verteuil (3) gave the following analysis of trees in a field at River Estate from three years' records :—

Yield per annum.	*Per cent.*
0- 12 pods..	23
13- 25 do.	20
26- 50 do.	30.4
51- 75 do.	15.9
76-100 do.	6.0
over 100 do.	4.7

Two years later(4) he supplemented this by records from three years' observations on three private estates in Trinidad and one in Tobago. For the two lower groups these showed :

	TREES BEARING	
	0-12 *pods.*	13-25 *pods.*
	Per cent.	Per cent.
Estate A.. ..	51.8	22.0
do. B.. ..	40.8	21.6
do. C.. ..	31.1	20.6
do. D.. ..	12.6	17.0

Estate D, Roxburgh, Tobago, stands out prominently. The owner had planted most of his trees himself from carefully selected seed. The other estates give the results of ordinary contract planting.

The data show the presence on estates in the Colony of anything from 20 to 50 per cent. of very poor bearers, yielding not more than 1 lb. of cacao each, and about another 20 per cent. giving below 2 lb. each. These figures are sufficient to account in great measure for the poor yields per acre so commonly obtained.

Replacement of the Poor Bearer.

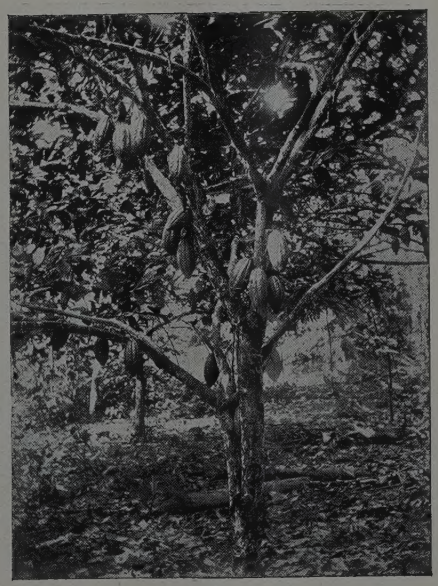
Having established that there are natural heavy and poor bearing cacao trees, and that a large proportion of the latter are normally present on cacao estates, the question naturally arose as how this condition of affairs could be improved. In the crop year of 1919-20 all the trees in a block of 3,000 in Field 2 at River Estate, which had a lower average than 18 pods per annum were removed and replaced by seedlings or budded plants from known heavy bearers. In 1924-25 the plants used for replacement began to come into bearing. Taking as an example seven of the best developed of these seedlings, they gave last season 26 lb. of dry cacao, in place of only 3 lb., the average yield for seven years of the poor bearers they have replaced. In other words with a very moderate expenditure and the loss of an almost negligible crop for five years, the yield of a group of trees has been multiplied nearly nine times. Such work carried out on a large scale would have a very marked effect on the cacao production of the Colony. It is of importance to stress the fact that it is quite practicable because the opposite view has quite recently been expressed by C. A. Barber (5) who, in discussing this problem of the poor bearer, says: "The evil is very difficult to remedy, for one cannot replant; it is idle to expect a seedling to survive when surrounded by a plantation of mature trees . . . The only possible way of improving these poor bearers would appear to be by grafting: they cannot be simply cut out, because of the injurious influence of the sun on the soil and of the wind on the other trees."

Is Heavy Bearing Hereditary ?

When experimental work to test the practicability of successfully replacing the poor bearer was started there were no data available to show whether heavy bearing was an hereditary quality or not. It was assumed on general grounds that it would be of advantage to use the progeny of selected heavy bearers, and on this same assumption all the plants sold to planters by the Department have been raised from heavy bearers There was also the possibility that to secure the transmission of heavy bearing qualities it might be necessary to resort to means of vegetative. propagation. The method in vogue for cacao was inarching or grafting by approach, which was too expensive for work on a large scale. The budding of cacao had been accomplished but had not reached the stage of an economic proposition for estate purposes. In 1913 the writer initiated Departmental work to test the practical

CACAO RESEARCH

Replacing Poor Bearers at River Estate, Trinidad.



A cacao tree in bearing.
(By the courtesy of Economic Geography.)

CACAO RESEARCH.

Gathering cacao pods, a bountiful harvest. (*By the courtesy of Economic Geography*)

Breaking the pods and extracting the marketable product.
(*By the courtesy of Economic Geography.*)

possibilities of the method, with successful results through the efforts of J. C. Augustus, and J. de Verteuil as described in 1914(6) and 1916(7). In 1914 an experiment was started at River Estate to test the comparative value of the progeny—seedlings, budded plants and grafted plants—from 28 selected heavy bearing trees.

Six plots of one acre each—280 trees to the acre, planted 12 feet by 12 feet were laid out with ten plants in each from each of the 28 selected parents, the progeny of each parent occupying a similar position in each plot.

Two plots contained seedlings, one acre with permanent shade trees and one without.

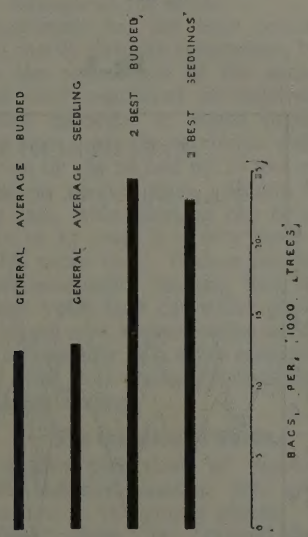
Three plots contained budded plants, two acres with shade and one without.

One plot was of grafted plants with shade.

The trees began to bear in 1917-18 and since then the number of pods borne by each tree has been recorded. In 1924 S. C. Harland, then Professor of Botany at the Imperial College of Tropical Agriculture, wrote a brief paper (8) summarizing the conclusions which could be drawn from the data then available. Last year he kindly analysed the results to the end of the crop year 1927-28(9).

In Figure 1 Harland shews the mean yield of the budded and seedling plants during the whole fruiting period, and in Figure 2 the mean results for the last two crops of the general average of the budded and seedling plots, and of the budded and seedling progeny, from the two best parent trees in each series.

Fig. 2.



The general conclusions at which he arrives are indicated by the following quotations :—

"A heavy bearing tree may transmit heavy yield to its budded offspring. On the other hand it may absolutely fail to transmit and may give rise to trees which are much worse than the average. There is no method of telling whether a tree will transmit heavy yield either to its budded or seedling offspring except by testing it."

"It has been shown at River Estate that it is possible to use supplies to replace poor yielders on estates provided that the supplies are of fair size when they are put in. It is recommended that the following types be concentrated on :—

Budded Nos. 1480 and 2190.
Seedlings Nos. 407 and 969.

"These may confidently be expected to give an increase over ordinary trees of more than 60 per cent."

Work on similar lines was initiated by the Gold Coast Department of Agriculture in 1914, and a summary of the results obtained so far has recently appeared.(10) The occurrence of trees which are consistently high bearers has been ascertained, and it is stated that "the next step is the propagation of progeny of the selected plants and their careful trial by the Department. It should not be forgotten that the high yields of these plants may not be inherent, but may be due to specially favourable situations in the field, and *that trial of the second generation is therefore necessary*."

The results of this trial will be awaited with interest. Meanwhile, for the first time in the history of cacao, so far as the writer is aware, the planters in Trinidad and Tobago have available for their use trees which have been proved to transmit to their progeny their own heavy bearing qualities.

Many thousand seedlings raised from the best bearing trees at River, have been sold to estates in the Colony. The mode of selection has been modified with increasing knowledge.

At first there were no data at all of the yield of the parent trees. These plants were propagated only from known heavy bearers. Now the stage has been reached of being able to propagate from heavy bearers known to be good transmitters of this important characteristic.

The development of this work has been recently described by R. O. Williams, Superintendent of the Royal Botanic Gardens (11).

The Spacing of Trees or Planting Distance.

Another question to which a definite answer is necessary in helping to solve the problem of how to get the most cacao from a given area of land, is : What is the best planting distance ? In Trinidad the most common spacing is 12 feet by 12 feet although wider spacing is not infrequent. To put the matter to a test, four plots of one acre each, were planted in 1913-14 at River Estate at respectively 12 feet by 12 feet, 14 feet by 14 feet, 16 feet by 16 feet and 18 feet by 18 feet. Records have been kept of the yield of each tree. The graph in Figure 3 shows the yields of the four plots from the first bearing in 1917-18 to the close of the crop season of 1927-28, expressed as pods per acre. Division by 1,815 (11 pods to 1 lb. of cacao in this case, and 165 lb. to the bag) will

Fig. 1.

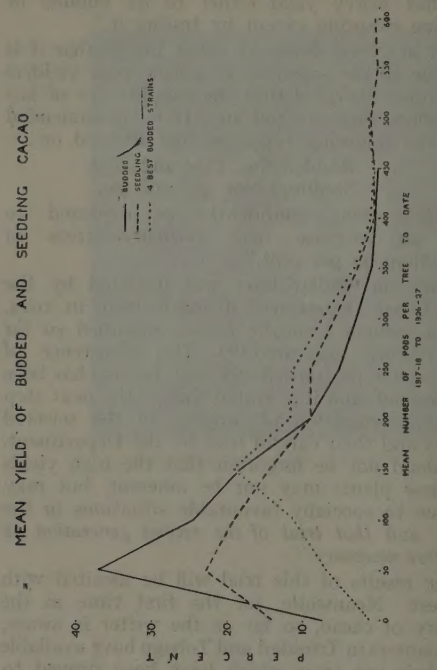


Fig. 4.

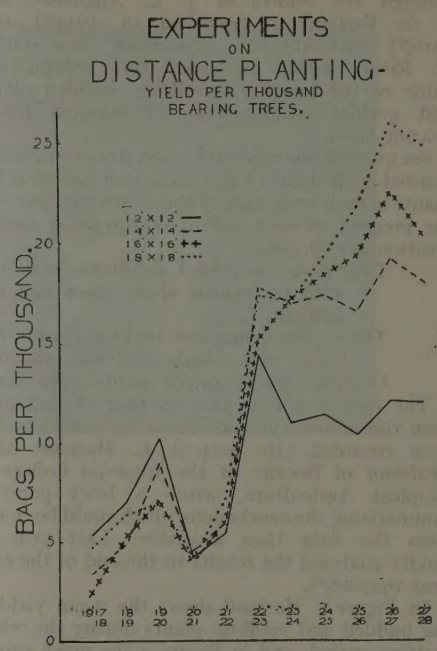


Fig. 3.

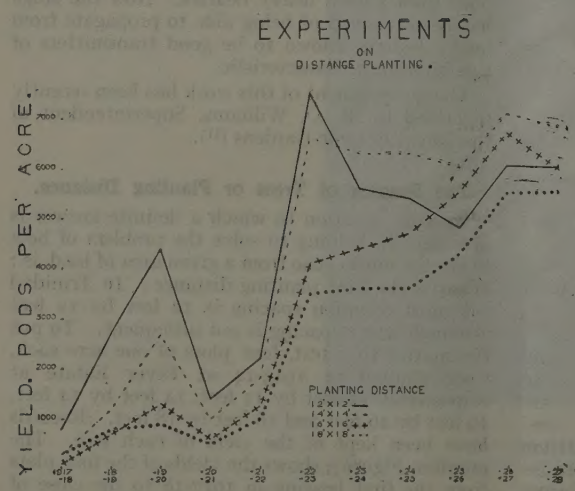
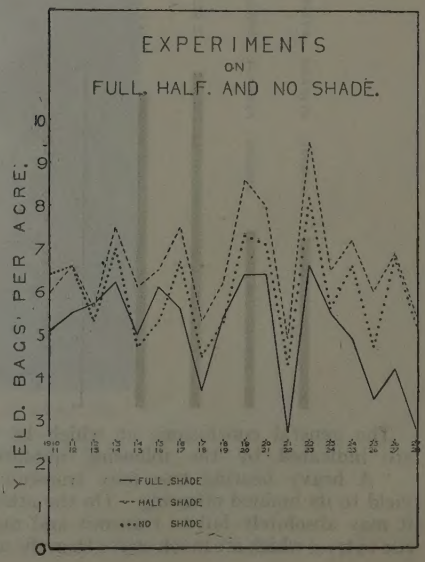


Fig. 5.



convert the yields into bags per acre. It will be seen that for six years the 12 feet by 12 feet plot gave the greatest yield, followed by the others in order. The following year the 14 feet by 14 feet plot took first place which it still retains, and two years later the 16 feet by 16 feet plot also passed the 12 feet by 12 feet. In 1927-28 the 16 feet by 16 feet had a set back for some unknown reason.

For the year 1927-28 the yields per acre were :—

Planting Distance.	*Bags per Acre.*
12 feet by 12 feet	3.3
14 feet by 14 feet	3.7
16 feet by 16 feet	3.3
18 feet by 18 feet	3.0

For the period of eleven years since bearing commenced the total yields have been :—

Planting Distance.	*Total yield 11 years.* Bags.
12 feet by 12 feet	25.5
14 feet by 14 feet	25.5
16 feet by 16 feet	19.4
18 feet by 18 feet	16.1

The 14 feet by 14 feet plot although at first surpassed by the 12 feet by 12 feet is now giving more cacao per acre, and has also given just as much during the total period of eleven years. In Figure 4 the results are presented per 1,000 bearing trees, from which it is seen that whilst for a very few years the more closely planted trees yield the most, this advantage is soon lost. Since 1922-23 the 12 feet by 12 feet plot has declined, the 14 feet by 14 feet plot has made but little progress, whilst both the 16 feet by 16 feet and the 18 feet by 18 feet have continued to advance, disregarding the probably temporary drop in 1927-28 which was a comparatively poor crop year throughout the estate.

The experiment has not been continued long enough to justify definite conclusions but having regard to the appearance of the wider planted trees, and their continued development in size and bearing capacity, it seems probable that after a few more years the maximum yield per acre will be iven by the 16 feet by 16 feet or possibly the 18 feet by 18 feet trees. Should this prove to be the case, wide planting can be advocated because 10 or 15 years is a very short period in the life of a cacao tree. It does not follow that there need necessarily be any loss of revenue during these years that the wider planted cacao is giving less per acre, because coffee could probably be grown successfully as a catch crop and allowed to remain until it is gradually smothered out as the cacao trees develop.

The Question of Shade.

When a new plantation of cacao is being established, bananas, cassava, &c., are used to give protection to the young plants. These are usually called "minor" or "ground shade" and are universally regarded as essential. In addition certain trees are frequently planted at regular intervals to serve as permanent shade trees to the mature cacao. The majority of the trees so used are leguminous, species of *Erythrina*, *Gliricidia*, &c., and the selection of these particular trees was made very early in the history of cacao cultivation. The question of shade, *i.e.*: permanent shade, has long been a controversial one, and the advocates of diametrically opposed views have no difficulty in finding ample data to support their respective cases. One thing seems certain. The effects of varying degrees of shade are not directly due to variations in the amount of sunlight to which the cacao trees are subjected. Shade trees act partly as overhead wind breaks and their effect in this particular can be compensated for in other ways. The degree of shade also apparently has a direct influence in determining humidity and in consequence the incidence of certain diseases such as black pod due to *Phytophthora Faberi*.

Shade trees which usually have a vigorous and far reaching root system compete with the cacao trees for available plant food and also water. The problem is a complex one in which it is difficult to separate the various factors. In order to endeavour to obtain some actual facts of the effects of growing cacao under varying degrees of shade under the conditions at River Estate, experiments were started in 1910. In one of these, three adjacent blocks of cacao in one field were marked out. Each block contained 500 trees, planted 15 feet by 15 feet, *i.e.*: a little over two acres, of cacao then about 40 years old. In one block all the shade trees and in another half the shade trees were removed, whilst the third was left undisturbed. These blocks are described as No Shade, Half Shade and Full Shade. Until three years ago when some manurial experiments were initiated in each of these blocks, they received no special cultural or other treatment, and what they have received since then has been identical in each block. The pod records have been kept for each tree since 1910, and the total yield in bags per acre computed from these. The results for the period 1910-11 to 1927-28 are shown in Figure 5.

The Full Shade in 1910-11 had a yield of 5.1 bags per acre; has ranged between 2.6 and 6.6 bags, and shows an average over the 18 years of 5.06 bags. The Half Shade began in 1910-11 with a yield of 6.0 bags; has ranged between 4.9 and 9.5 and given an average yield of 6.7 bags. The No Shade, started in 1910-11 with 6.4 bags; has ranged between 4.3 and 8.2 and given an average of 5.96 bags.

The Half Shade cacao throughout the experiment appears to exhibit greater adaptability to varying seasonal conditions particularly as compared with the Full Shade. Its crops reach a higher level in the good years and do not sink so low in the bad years. The No Shade keeps fairly consistently an intermediate position. The fully shaded cacao usually has a short cropping period, from about November to January, the worst months for black pod disease. In the Half and No Shade cacao the crop is more prolonged, and the incidence of black pod is lower. In the figures used for the graph the performance of the Full Shade is flattered, because pod records have

been kept, and mature black pods thus included, although of course they have when gathered to be handled separately and produce a cacao of lower commercial quality which is disposed of for local purposes at a low price.

The general conclusions which have been drawn from this experiment are that the lightly shaded cacao gives the greatest yield per acre, that the crop is borne through a longer fruiting season which makes it easier to handle and both lightly shaded and no shade cacao have a much lower incidence of black pod disease.

Similar results have been obtained over larger areas at River Estate where shade has been gradually reduced and where necessary protection from wind provided by planting mahogany trees along the traces between the cacao fields. Work on these lines forms part of the general practice and advice of the Department, due regard being paid to local conditions.

Tillage and Manuring.

It would extend this article unduly to enter into a detailed discussion of methods of tillage and manuring. The work at River started with manurial experiments and in the reports by de Verteuil already referred to it will be found that in very few cases were the results financially profitable. More attention was then given to tillage and, passing through a stage of ordinary forking, L. Seheult, Superintendent of River and Cacao Agronomist, devised a system of trenching. Continuous shallow trenches, about 2 feet wide and 16 to 18 inches deep are dug midway between every row, or every other row of cacao trees. In heavy soil their ends open into the main drains to avoid any possibility of waterlogging. The trenches are filled up with the cut up portions of shade trees removed, weedings, hedge trimmings, &c., then a dressing of pen manure, 15 to 20 tons to the acre if obtainable, and finally covered with the earth removed in making the trench, so that the result is a series of raised mounds which gradually sink to the original level. The programme is to do this work field by field, about once every five years. The results have been uniformly good, as shown not only by increased crops, but in increased resistance to the attacks of such a pest as thrips, to diseases such as Algal disease (*Cephaleuros Mycoidea*), &c. The beneficial results are in many cases immediate and striking, and they are also lasting.

There is in the minds of many planters a strong prejudice against any disturbance of the roots of the cacao tree, and even quite recently the same view has been expressed in publications by scientific writers, without, however, the presentation of any supporting data. In practice at River Estate the bad results hypothecated by these planters and writers have not occurred, and there is also the experience of Grenada where intensive cultivation, including thorough forking, and the digging of pits which entail root pruning has long been practised with very satisfactory results.

The objects to be aimed at in cacao cultivation are apparently sufficient drainage, tillage and incorporation of organic matter to permit better aeration of the soil, make more uniform its water holding capacity, and encourage a deeper root system. By these means the health and vigour of the trees are increased, resulting in greater crops both directly, and indirectly by greater resistance to some of the principal diseases and pests.

Summary.

In this brief account of some of the principal lines of work which have been prosecuted at River Estate for now close upon twenty years, it will be recognised that the main objective has been increased production per acre. At first this was doubtless the case although not definitely expressed.

In 1919 ([2]) in giving a summary of the work to the Agricultural Society at River the writer pointed out that the experiments on cacao could be made with two objects in view :—

"(1) To improve the quality of the product.
(2) To increase the quantity of the produce from a given area of land."

In 1923 ([12]) at a similar meeting held during the period of unremunerative prices due largely to the competition of cheap supplies from other sources, I put the position in these words :—

"To enter into successful competition two courses seem open :
(1) To produce cacao of a quality for which manufacturers are prepared to pay a higher price.
(2) To increase our profit by producing larger crops on the same acreage and reducing cost of production."

Again in 1928 ([13]) dealing with the same question, the difficulty of making a fundamental change in quality was pointed out. Cacao is not a short period crop like wheat, cotton or sugar-cane in which one variety can be replaced by another. It is a long period crop and a large area under mature cacao represents heavy capital expenditure. Even the utilization of a choicer variety for new plantings on an estate would mean but little improvement, as the produce of an estate is in practice bulked. It would be very difficult to cure and market one portion separately, as can be done with a particular variety say of citrus or mango.

In practice, therefore, the owner of an established cacao property is restricted to making the best of such cacao as he has. He can improve quality within certain limits by picking only ripe pods, fermenting properly, taking care that, the cacao is well dried, and graded, but he cannot by any wave of a wand produce a Criollo cacao from Forastero.

Work has been done at River and elsewhere in converting trees by budding. Basal suckers are desirable and suitable ones are not always easy to obtain. In any case it entails the loss of the crop from the existing trees and so is usually not within the means of the planter unless he has other sources of subsistence.

This being the case his efforts must primarily be directed to increasing his production at the lowest possible cost, and maintaining as high a standard of quality as is practicable for the variety of cacao he has under cultivation. The work at River has demonstrated some ways in which this can be done. It has proved the existence of natural good and bad bearers, that there are large numbers of the latter on all estates, also that heavy bearers can be selected which transmit their heavy bearing characteristics to their progeny, and that these can be used for new plantings or the replacement of poor bearers with profitable results. The results of the distance planting experiments indicate that an alteration in the conventional distance, so far as Trinidad is concerned, may also lead to a larger production per acre. Similarly, the work on shade requirements and cultural treatment point to the same conclusion, not only as regards an actual increase in crop but by minimizing the losses due to some of the principal diseases and pests.

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NORTH BORNEO TOBACCO CULTURE.

(*The following is a summary of an article by Mr. R. C. Dealtry on the cultivation of tobacco in North Borneo.*)

TOBACCO culture in Borneo is mainly confined to the river banks, where good tobacco of light colour, which is exceptionally suitable for present-day demands, is found growing as a rule on "Tanjong" land, *i.e.*: land that juts out into the river. Hilly land, even on low hills, is most unsuitable as many experiments which have been made in planting this type of land and using various artificial manures have failed. It has been found that the soil must be allowed a rest of six or seven years before a second crop can be planted, and that sandy loam which is only obtainable on the river banks is the most suitable for tobacco.

Each tobacco 'field' which is on an average just over one and a half acres is managed by a Chinese coolie who is paid yearly on a profit-sharing system which (at a certain rate per thousand plants) is based on the amount planted and the condition in which the tobacco is kept. About 20,000 seedlings can be grown on a 'field' but really good coolies are sometimes allowed extra land to plant slightly more than this number. In addition to the planting money the field coolie receives payment for picking, sorting and, in the short period in between the crops, for draining and other minor operations. He recruits labourers who cultivate the tobacco for him, search for caterpillars and so on.

Methods of cultivation, harvesting and curing.

On land which has already been planted, the old drains are opened up before the jungle is cut. With virgin jungle, the land should be drained first, and where the soil is heavy it should be drained and the jungle cut as early as possible, as more time is required for the latter to dry before it is burnt off.

After all conveniently sized pieces of timber have been carried off the fields and taken to the Drying Sheds where they are used for fires, the remaining timber is stacked and burnt off and the land prepared for *changkolling* (turning over the soil with large heavy hoes) so as to aerate the soil. In Sumatra this *changkolling* is always done twice but, in my experience, this is not necessary in Darvel Bay. After *changkolling*, the land is raked and prepared for planting.

Work starts generally about the beginning of the year and by the first week in February the coolies will be ready to prepare their seedbeds. Seeds are either sown mixed with wood ashes, and then scattered over the beds, or mixed with water and distributed by means of a watering-can. As a deterrent to ants, which carry the seeds away, the beds may be sprayed with a solution of Crude Oil and water before sowing. The seeds

should germinate after five days and are transplanted to the fields about 40 days after they are sown, the seedlings being sprayed regularly with lead arsenate solution. Care must be taken that the seedbeds are thinned whenever necessary.

Planting should start not later than the third week in March, and should not extend, at the utmost, more than two months; less than this is better, but conditions such as floods &c. may make this impossible. After the plants have been in the ground a few days they are given a small bank, *i.e*: they are ridged up; later on they will require a second bank and in places, a third bank if necessary. The object of banking is to help the plants to throw out roots and to keep them from blowing over in storms.

About 80 days from the time of sowing the lower leaves (Sand leaves) are ready for picking. The plants bear four grades of leaves, Sand, Foot, Middle and Top, and a plant with 24 leaves would give four Sand, eight Foot, eight Middle and four Top. The lower leaves, *i.e.*: Sand and Foot, are by far the most valuable, Sandleaf being, at the present time, very much in demand by continental buyers. The plants should be completely harvested in about 100 to 115 days.

After the tobacco has been inspected by the officer-in-charge it is hung up in the drying sheds. Sandleaf can be hung slightly closer than the other grades as the leaves are small, but in the case of Footleaf, which has large leaves, it is advisable to give plenty of space, otherwise sweating will occur. After the leaves have been hanging in the drying sheds five or six days, wood fires should be started *round* the tobacco, then, after a further period of two days, *under* the tobacco. The curing of tobacco is undoubtedly one of the most difficult problems in this country, where, complicated by the intensity of the prevailing mists, it requires constant supervision and a long knowledge of local conditions to get the desired effect. The leaves should be dry in about 20 days, with the exception of Sandleaf which takes only 18 days under normal conditions. After the tobacco is dry, it is taken to the fermenting shed where it is made up into bundles containing about 40 leaves each. These are stacked and fermented naturally, no artificial heat being applied. The first stack made weighs about 4,000 lb. This in turn is mixed with another stack of the same size and grade and the process continued until a stack of about 32,000 lb. is made.

The finished leaves are carefully graded, measured and made up into bales of 80 kilogrammes (176 lb.), the tobacco stapled carefully in boxes, pressed down to a thickness of nine inches and then sewn in grass mats marked with the grade, length of leaf and the number of the shipment.

The drying sheds, labourers' barracks and other buildings are made by Javanese labour, while the actual planting of the tobacco is done by Chinese. A drying shed is rather like a large barn and consists of 35 to 40 rooms, each room being six feet by 60 feet, the height from the ground to the apex of the roof being about 38 feet. The number of rooms required is five to each field; each room being provided with shutters so as to ensure proper ventilation. The sheds and all other buildings are roofed with Nipah palm leaves.

Assistants who have some knowledge of the language and of looking after labour are each put in charge of a division of 40 fields; older and more experienced assistants generally managing double this number of fields. Each assistant has under him a Chinese overseer, locally called a "Tandil," for about 40 fields, and a gang of Javanese for his buildings.

The yield of tobacco obtained from a 'field' varies greatly according to the land and the weather conditions—1,600 lb. being good, 1,860 to 2,000 lb. exceedingly good, while 1,330 lb. may be considered a good average crop. The average number of leaves per picul (133 lb.) over the whole crop is about 30,000. Sandleaf is always lightest, being in the vicinity of 40,000. Favourable conditions for obtaining a good crop may be summarised as follows: Dry weather when *changkolling*, so that the land may become well aerated, and sufficient rain while the tobacco is being planted and picked. Long periods of dry weather of two to three weeks duration are very detrimental to the crop, as the leaves become too oily, sticky, thick and of indifferent colour. One of the reasons for not being able to plant the hinterland, is that it is apt to be flooded from the jungle as, in most cases, the river banks are higher, with the exception of "Tanjongs." Great care must be taken to keep caterpillars in check as a broken leaf loses much of its value as a wrapper leaf.

Note—A 'field' is roughly 1.5 acres. The average yield is given as 886 lb. or 6.6 piculs, containing about 19,800 leaves. At 2 feet by 2 feet spacing, there will be 10,890 plants per acre, implying 18 leaves per plant, a figure which seems high in view of the poor total yield.

R. C. W.

SOUTH AFRICAN MAIZE.

Expectations of a bumper maize crop in South Africa this season are not likely to be realised, owing to the general lateness of the rains, the long droughty periods in some areas, the marked prevalence of the stalk-borer in many districts, and the shortage of the area placed under cultivation owing to the late rains. In official quarters in Pretoria the crop is expected, if not to equal, to be only slightly less than, that for last season; roughly it is calculated at 20,000,000 bags. Estimating is now proceeding, and the areas placed under cultivation will soon be ascertained. There is a widespread fear that early frosts may do further damage.—(*Times Trade and Engineering Supplement*, Vol. XXIII, No. 557.)

GUMMING DISEASE OF SUGAR-CANE.

The Bacterium which causes Gumming Disease of Sugar-Canes with Notes on two other Bacterial Diseases of the same host.

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IN an earlier number of this Journal (March 1926; Vol. III, No. 3, pp. 50-51) an account was given of the occurrence of Gumming Disease in St. Kitts and St. Lucia. The most generally characteristic symptom of the disease noted was the presence of long narrow pale translucent stripes on the leaves; the stripes showed brown specks and frequently fine red streaks and ended in broader dead stripes towards the tips of the leaves. In some varieties an additional symptom was present in the form of red vascular strands in nodes and internodes from which a yellow gum or slime oozed out when they were cut; in these varieties, cavities were present occasionally on the youngest internodes filled with the same yellow gum. Those varieties such as H 109, Ba 11569 and White Transparent which showed both leaf and stalk symptoms were considered to be notably susceptible to the disease; varieties such as Ba 6032 and D 109 which showed, as a rule, only the leaf signs, were regarded as semi-resistant, while such kinds as BH 10 (12) and SC 12/4 which showed no leaf stripes in St. Kitts appeared to be highly resistant. As the semi-resistant varieties might be expected, under external conditions favourable to this disease, to show "gumming" in the stalks and in consequence suffer more or less appreciably in tonnage and in quality of the juice, it was recommended that only the highly resistant kinds be propagated and this procedure has been followed by the planters in St. Kitts. There were good grounds for adopting this course as the disease had been effectively controlled in Brazil and Mauritius many years earlier by replacing the susceptible variety or varieties then under cultivation by highly resistant kinds and the same method had been and was still proving valuable in Australia and Fiji whenever the disease became introduced or reintroduced into areas when susceptible kinds had come to be grown widely.

Cobb in Australia some forty years ago was the first investigator to find that the stalk symptoms were associated regularly with the presence of bacteria in the xylem vessels of the vascular strands and that the gum or slime which oozed from the severed ends of the vasculars was filled with, apparently, one kind of bacterium to which he gave the name *Bacillus vascularum*. Some years later Greig Smith isolated and studied the cultural characters of the organism and the nature of the gum and Erwin F. Smith (1) in Washington, D.C., isolated it from specimens of gummed cane stalks sent to him from Australia, described its morphological and cultural characters and innoculated it successfully by means of needle pricks into the leaves of many varieties, obtaining leaf stripes and gumming of the stalks in a number of instances. He found it to be a short rod-shaped form motile by means of one polar flagellum and called it in conformity with his nomenclature *Bacterium vascularum* (*Cobb*) *G. Smith*. He described it as a rather slow growing organism forming entire glistening honey yellow colonies on nutrient agar and a restricted deeper yellow glistening growth on potato blocks. His isolation did not liquefy gelatine but turned litmus milk (separated) gradually rather strongly alkaline without clotting it and without clearing it subsequently.

Platings in peptone saccharose agar made with yellow ooze from the stalks of affected canes in St. Kitts yielded two types of colonies, those, the more rapidly appearing (3 to 4 days) being entire convex, glistening and, at first, colourless but later pale yellow and spreading: the later appearing colonies were entire flat, deeper yellow, and the growth more restricted. The first type of colony yielded a straw or amber yellow (Ridgway) abundant slimy growth on slanted agar in tubes with a marked tendency to run down and accumulate at the bottom of the slope; after inoculating into milk a shallow clear zone formed at the top of the liquid in two or three days at tropical room temperature with a bulky indistinct clot apparently due to a lab-enzyme and the reaction became increasingly alkaline. The second more slowly growing type of colony which was yellow from the start yielded a restricted glistening aniline to primuline yellow growth on the agar with a compact slime showing little tendency to flow. In litmus and plain milk no change occurred in a week but there was gradual increase of alkalinity subsequently. As the organism in the first type of colony showed cultural characters different from those of *B. vascularum* as described by Erwin F. Smith and as those of the second type were in agreement with his description, the first type was discarded and attention given to the second. Inoculations with pure cultures of it made by means of needle pricks into the folded leaves above the growing point of actively developing young shoots of Bourbon cane, arising from cuttings planted in pots of soil, resulted in the formation of leaf stripes and red colouration of vascular strands in the apical internodes of the stems from which yellow gum oozed when they were cut; isolations from the leaf stripes and vascular bundles of the stems yielded colonies of an organism apparently identical in cultural characters with those of the form used for inoculation.

When the author went to England Mr. D. S. North very kindly sent him cultures of an isolation which he had made from "gummed" cane in New South Wales and had found following inoculation to cause the characteristic symptoms of the disease. This form and also the second type from "gummed" cane in St. Kitts were inoculated independently into young ratoon shoots of the varieties Badila, B 156, and BH 10 (12) (the St. Kitts form also into Uba) which were

growing in pots of soil in a heated glass house; the inoculations were made with young cultures growing on peptone saccharose agar into the folded leaves in the hearts of the shoots by means of needle pricks and uninoculated controls were maintained.

The inoculations of the St. Kitts organism caused the development of long narrow pale sharply defined translucent stripes about two mms. in width on the punctured leaves of the four varieties; the stripes showed reddish brown specks and in some instances fine red streaks. The plants were allowed to grow on for several months but the stripes remained restricted to the pricked leaves and the hearts did not wither nor did the apical internodes rot. When examination was made about five months after the inoculations, isolated red streaks due to infection of single vascular strands could be traced down some of the leaf sheaths and were continued into one or two of the internodes. Isolations were made by means of poured plates from leaf-stripes 20 to 30 cms. from the inoculation pricks, from the leafsheaths and from reddened vasculars in the stems and colonies obtained similar to (an exception is mentioned later) those of the form used for inoculation but showing some minor variations in cultural behaviour.

Inoculations with the isolation from Australia resulted in the formation of broader leaf stripes with more diffused margins on the pricked leaves and withering of the hearts and rotting of the apical internodes of the shoots of B 156 and Badilla.

Isolations from leaf stripes 20 to 30 cms. from the pricks, from leafsheaths and from reddened vasculars in the young internodes yielded an organism essentially similar to that used for inoculation. The Australian isolation appeared, therefore, to be the more actively pathogenic form invading both the vessels of the xylem of vascular bundles and causing a necrosis of the parenchyma of young leaves and the apical internodes of the stems

The original cultures of the St. Kitts organism (second type of colony) gave rise to a glistening restricted growth on peptone-saccharose agar (saccharose 2.0, with peptone 0.5, dipotassium phosphate 0.05, magnesium sulphate 0.025, agar (bacto) 1.5, water 100.) between aniline and primuline yellow in colour (Ridgway); the slime was compact drawing out, in cultures which had attained their full growth, into elastic threads and showing little tendency to flow. The growth was opalescent in oblique light and gelatine (10 per cent.) of the same composition as the agar medium was slowly liquefied after two weeks. Lavender-colour litmus milk became gradually strongly alkaline and after two to three weeks at 23°C. began to clear from the surface with bleaching. After two to three months the milk had cleared with more or less suspended slime and restoration of the litmus colour but remained permanently strongly alkaline. If the milk carried a layer of fat a yellow growth developed on the surface and there was little deposit; in the semi-anaerobic conditions under the layer of fat, bleaching of the litmus was complete for a time, and it appeared that action on the milk was mainly by diffusion of metabolic products through the fat layer. In well separated milk, surface growth was restricted to a yellow ring, there was active multiplication within the liquid and a good yellow deposit associated with partial bleaching and more rapid restoration of the litmus colour. It is doubtful if, at any time, a true clot was formed, the eventual clearing being apparently due to increasing alkalinity since cleared cultures yielded a bulky precipitate when acidified with hydrochloric acid. The organism which was actively motile in young liquid cultures by means of a single polar flagellum exceeded 0.5 microns in diameter and was from 1.0 to 1.5 microns in length occurring singly, in pairs and more rarely in short chains. Most of the isolations showed colonies similar to those of the original isolation but those from the leaf stripes of Uba were dry, flat, rough and pale yellow with wavy margins, the growth from these colonies on agar slants was at first similar but tended gradually to take on the glistening smooth deeper yellow charater of the original form. Some of the cultures from the isolations caused, like the original, a slow liquefaction of gelatine but others showed no trace of liquefaction at room temperatures after three months. The action on milk varied in the rate of change but there was no true clot and all eventually cleared with persistent alkalinity.

The original culture from Australia gave rise on the agar to convex glistening almost colourless colonies of a fluid slimy consistency which became paler yellow and spreading. On agar slants the growth was abundant opalescent and fluid slimy with a tint from straw to amber yellow: the slime tended to flow and accumulate at the base of the slant. On potato the growth was sulphur yellow fluid and flowing off the surface but not so abundantly as the slime of *B. Malvacearum E. F. Smith.* Gelatine showed liquefaction under a week and a shallow clear zone formed at the surface of plain and litmus milk after three to four days at 23°C associated with the formation of a bulky indistinct clot apparently due to a lab-enzyme; alkalinity gradually increased becoming strong and persistent and the milk was completely cleared after two to three months of 23°C; the clearing appeared to be caused by peptonisation as no precipitation followed acidification with hydrochloric acid. Growth occurred as a yellow slimy layer on the surface of milk with fat present and absent. The organism was actively motile in young cultures and approximated in size to that of the St. Kitts form.

The colonies which appeared in platings made from the inoculated canes were not uniform in type; some resembled those of the original culture, but they were as a rule, mingled with others showing a piled up deeper yellow colour, a dark opaque nucleus, and little tendency to spread; others again were at first flat, but changed to the second type after a few days. Transfers from the different colonies to agar

slants yielded, however, a similar pale yellow slimy fluid growth like that of the original form. All cultures from isolations behaved like the original culture in liquefying gelatine appreciably within a week and clotting milk in three to four days at 23°C. with gradually increasing alkalinity and in clearing it eventually but with marked differences in the rate of clearing as cultures from the second or "piled" up type of colony were slower in action. The isolation from Australia, showed therefore, cultural characters similar to those of the first type from "gummed" cane in St. Kitts, and it is believed now that they are probably identical. As the cultures made from the isolations out of the different varieties were essentially similar to the two types used for inoculation, and as no evidence was obtained that the one type could change into the other, it would appear that two yellow forms may cause Gumming Disease, occurring in some instances together and which differ in cultural characters enough to be considered as distinct varieties of *B. vascularum*. The strain described by Erwin F. Smith resembles the second type from St. Kitts differing from some cultures of it only in not eventually clearing milk a difference which appears to depend on the amount of alkali produced; the alkaline body is either ammonia or an amine as the vapour from boiling cultures turns red litmus paper blue. The formation of leaf stripes following inoculation of the young leaves of the four varieties including Uba points to the probability that most, if not all canes, cultivated in the tropics are susceptible to leaf infections. The rarity or absence of stalk infection in Ba 6032 and D 109 noted in St. Kitts indicated that the disease might remain restricted to the leaves. Examination of the inoculated cane showed however that bacteria might grow down single vascular strands into the stalk causing a slight but easily overlooked infection doubtless transmissable in cuttings taken from such stalks.

North ([2]) has recorded some preliminary results of an intensive study of the disease in New South Wales. He observed that rain and wind during storms were effective in transmitting infection from leaves of diseased cane to leaves of healthy cane; when infected leaves are wetted by rain the bacteria ooze out freely to the surface of the stripes and can be scattered in rain drops by splashing and by wind. Infection occurs only on leaves which have been wounded by scratching or rubbing or by tearing due to the wind. The spines along the margins of the leaves are a frequent cause of minute wounds or scratches on adjacent leaves during a storm. Bacteria introduced into such wounds give rise to stripes in two or three weeks. He was unable to get evidence that sucking insects transmit the disease, but found indications that long distance transport of the bacteria was due probably to flies which have a liking for the bacterial ooze from the stripes and may carry it on their bodies when flying away to suck the sap exuding from slight wounds on healthy leaves at distances as great as a quarter mile from the nearest diseased plant. He inferred, therefore, that Gumming Disease is primarily a wound disease of the cane leaf and that the leaf stripes are the most critical signs of infection. The disease may remain restricted to the leaves and the bacteria grow through the vascular strands into the stalks and give rise to "gumming" only under conditions which favour the disease. It is probable that the lowered resistance of the tissues induced by excess of moisture in low lying poorly drained soils may result in such extension of infection from the leaves into the stalks. The writer's observations in St. Kitts and St. Lucia appeared to support the view that infection may be confined to the leaves of some resistant varieties. Attention may be drawn to this circumstance as in some areas where resistant varieties are under cultivation the leaf stripe form of the disease may be present unrecognised because the "gumming" of the stalks has not been detected. Abnormal conditions such as those brought about by a hurricane might however, lower resistance temporarily and result in appreciable losses due to "gumming" of the stalks and wider extension of the disease by the planting of cuttings from such stalks: with an increase of the number of plants developing leaf stripes due to infection through the cutting an opportunity would be given for a further extensive spread of the disease by the air during rainy and windy weather. Varieties showing an appreciable amount of leaf striping should be considered as semi-resistant and with an eye on eventualities should not be allowed to occupy a large part of the area under cultivation. Gumming Disease is known to be present in Australia (Queensland and New South Wales) Fiji and Mauritius and in the West Indian region—in Porto Rico, St. Kitts, St. Lucia and Colombia.

Two other bacterial diseases, which are characterised by the presence of leaf stripes, attack sugar cane. One of them, known in Australia as Scald, causes long, narrow chlorotic translucent stripes on the leaves somewhat similar to those due to Gumming Disease, but distinguishable in the field by those acquainted with both diseases. Infection and red colouration of the vascular strands in the stalks occur in Scald, but there is no ooze of gum or slime when they are cut. The causal bacterium has been isolated by North ([3]) in Australia and inoculated successfully into cane. He has described it as a very slender (0.2 to 0.3 microns in diameter) rod-shaped form which grows more slowly than *B. vascularum* giving rise to flat entire yellowish colonies which do not form an appreciable slime. It tends to produce involution forms readily in culture and the action on milk is slow with no clotting but a gradual increase of alkalinity and final clearing. An earlier detailed study of apparently the same disease under the name "Gomziekte" was recorded by Wilbrink ([4]) in Java. Although both authors have described a number of the cultural characters of the organism neither has given a name to it. The writer has

examined a culture kindly furnished by North and has found the bacterium actively motile in young cultures, by means of a single polar flagellum three to five times the length of the rod and has not observed it to liquefy gelatine. The binomial *Bacterium albilineans* is proposed for it on account of the long white leaf stripes of uniform width which are characteristics of the disease. Scald is present in Australia, Fiji, Java, the Philippines, Mauritius ([5]), and probably in Formosa but has not been detected yet in the West Indian Region.

The third bacterial disease of sugar cane has been studied recently in detail by several investigators ([6]) in the Hawaiian Islands under the name Red Stripe Disease. It is characterised by the presence of short or long bright red stripes on the leaves and, in the very susceptible "Tip" canes, by a top rot also. The causal organism to which the binominal *Phytomonas rubrilineans* has been given forms white colonies and the cultural characters are in several respects different from those of the species causing Gumming Disease and Scald. Red Stripe Disease has been detected by Edgerton on a number of varieties in Louisiana, by Bolle in Java and is probably present also in Queensland. Both Scald and Red Stripe Disease can be controlled by the cultivation of good resistant varieties a number of which are available in territories where those diseases occur.

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* * *

Colonial Appointments.

The following appointments and transfers have been made by the Secretary of State for the Colonies during the month of February:—

Mr. G. N. Herington, Agricultural Instructor, Education Department, Nigeria.

Mr. N. R. Reid, M.R.C.V.S., Veterinary Officer, Tanganyika Territory.

Mr. D. D'Emmerez (Assistant Director of Agriculture, Mauritius), Director of Agriculture, Mauritius.

VITAMINS.

(*Continued.*)

By Alfred Clark, F.R.C.S.
Acting Govt. Pathologist, Trinidad.

III—Vitamin B.

The credit for the conception of a food accessory which prevents the occurrence of polyneuritis and beri-beri belongs to Grijns who stated in 1909 that the disease developed when the diet lacked certain substances (we should now say 'a certain substance') which were of importance in the metabolism of the peripheral nervous system. He found that these 'substances' could be restored to the diet by adding a bean, *phaseolus radiatus*, to the rice ration. He also demonstrated the destruction of the added factor at a temperature of 120° C. Fraser and Stanton sought to determine more accurately the nature of the beri-beri-preventing substance. They found that it was soluble in alcohol as well as in water and also thought that the percentage of P_2O_5 in rice was an index of the grain's value in preventing beri-beri.

This conclusion was followed by a loud and unmerited acclamation of the therapeutic value of organic phosphorous compounds and echoes of the mistaken applause still linger in the advertising columns.

Many attempts have been made to isolate this vitamin and whilst crystals of high anti-beri-beri potency have been obtained by prolonged and complicated processes, it does not yet appear that the pure substance has been prepared. It is true that substances containing vitamin B give a blue colour with phospho-tungstic and phospho-molybdic acids on the addition of sodium carbonate. This reaction was introduced by Folin and Macallum, and Funk showed that if an incision is made in the maize kernel and the test applied *in situ* the blue colour develops in the part known to be rich in vitamin B.

In heated extracts of the kernel the colour is paler, showing that the substance involved in the colour-reaction is destroyed by heat. We do not know, however, whether the blue colouration is caused by the action of the vitamin or of associated substances.

The biological test of the presence of B remains the only reliable one and yields definite and constant results. Within a few days from the stoppage of vitamin B the body temperature falls below normal and remains sub-normal until death occurs or the vitamin is again supplied. This is a useful laboratory indication.

As a routine procedure in testing individual food substances for their vitamin B content I feed a number of pigeons with a basal ration of a polished rice which has been proved to be free from the vitamin to the degree that polyneuritis is produced, when it is the sole food, in three weeks or about

that time and the substance to be tested is added to this basal ration in a definite proportion—usually 25 or 50 per cent. If the pigeons live upon this mixed diet for two months without developing polyneuritis it is assumed that the vitamin B content of the tested food is adequate. Sometimes the experimental finding is proved by placing the pigeons upon the basal diet of polished rice alone until the signs of polyneuritis are manifested and then administering the substance which is being tested. If the polyneuritis is cured the existence of vitamin B in adequate quantity is demonstrated.

In the accompanying photograph five pigeons are shown in a condition of polyneuritis which occurred simultaneously in all of them. They had been fed on equal parts of sweet potato and polished rice for 130 days and had maintained their health. The sweet potato was then withdrawn and in 18 days polyneuritis occurred. They were paralysed to such a degree that when placed upon the table in the open air to be photographed they were quite unable to escape. The positions assumed are characteristic of the polyneuritis of B deficiency, especially that of the bird with the retracted head. I may mention for the comfort of the tender-hearted that the administration of 1 gram of wheat embryo restores them to health. In a few hours—from 2 to 12—they are perching quite happily and taking their food with a good appetite. This constant reaction to deprivation of B and to its re-administration is one of the most dramatic in the field of modern biochemistry.

In small quantities vitamin B is widely distributed in both vegetable and animal foods, but the substances which constitute rich sources of it are not numerous and owing to the customary processes of refinement and cooking the diet of most civilised people is very deficient in this necessary factor.

Amongst the animal foods the vitamin is most abundant in the highly nuclear tissues—the brains, the liver, the sweetbread, the kidneys—and in tripe. The roe of fish must also be mentioned as an excellent food in this respect as also are egg yolks. In the vegetable world the vitamin is widely distributed, especially in those portions which are discarded in preparation and in those foods which are only eaten very occasionally.

The richest sources are the germ of cereals, yeast and its extract called 'marmite,' nuts of all kinds, peas, beans, lentils, spinach and tomatoes. Raw cabbage and lettuce contain a fair amount. The vitamin appears to be a complex body consisting of two factors, one of which, B_1, prevents polyneuritis and the other, B_2, is essential for growth and is possibly concerned in the prevention of pellagra, a disease common in communities where maize is the principal article of food. This B_2 is thermostable whilst B_1 is thermolabile.

It is important to remember that though vitamin A can be stored in reserve in the tissues of the body for use when required and that consequently growth does not cease until this reserve is exhausted, provided there is no other dietetic factor wanting, in the case of vitamin B there is no storage in the tissues and arrest of growth follows immediately when the daily supply is lacking.

In rats under certain conditions, however, the curious phenomenon called 'refection' is observed. The faeces become whitish in colour and very bulky and are eaten by the animals. By this diet the onset of the signs of vitamin B deficiency are indefinitely postponed. The phenomenon is rather rare but I have observed it in the case of rats in the Government Laboratories in Trinidad. When the wire floor of the cage is raised so that the faeces cannot be obtained the usual signs of B deficiency occur. This fact has not yet been satisfactorily explained.

I have found that tannia, yam, sweet potato and dholl, all of which are largely consumed in Trinidad, contain enough of this food factor when raw to prevent polyneutritis in pigeons when they constitute 50 per cent. of the diet. With regard to dholl, which, boiled with polished rice, constitutes the principal and sometimes the sole food of the East Indian population in this country some interesting results appeared when tried upon pigeons.

Thirty-two birds were divided into eight parties of four each and were fed as follows :—

Party *A* uncooked polished rice and dholl in equal parts.

B	the same	boiled	½ hour.
C	do.	do.	¾ do.
D	do.	do.	1 do.
E	do.	do.	1 ¼ do.
F	do.	do.	1½ do.
G	do.	do.	1¾ do.
H	do.	do.	2 do.

Party *A*	throve normally and laid eggs.		
B	do.	do	do.
C	do.	do.	do.
D	do.	do.	but laid no eggs.
E	do.	do.	do.
F	do.	do.	do.
G	do.	fairly do.	do.
H	lost weight steadily and laid no eggs.		

This experiment continued for over four months and none of the birds developed polyneuritis. The satisfactory vitamin B content of the dholl is therefore proved.

The pathological anatomy of animals dying of vitamin B deficiency shows well marked lesions.

1. *The nervous system* exhibits a fatty degeneration in which the axis cylinders are involved and which are probably of central origin though another interpretation of the phenomenon is of course possible. This degeneration is more marked in the hind- than fore-legs and it may also be demonstrated in the sub-divisions of the splanchnic nerves.

2. *The muscles* show signs of atrophy. This is evident in the muscular coats of the digestive organs as well as in the skeletal muscles.

3. *The heart* is usually pale, flabby and the right side is enlarged.

4. *The suprarenal glands* are usually enlarged.

In addition to these effects upon special organs there is a tendency to the accumulation of fluid in the pleura, pericardium and peritoneum as well as to oedema of the lower limbs. Minute haemorrhages occur in many organs, especially in the mucous membrane of the digestive tract.

It is probable that these effects are produced by vitamin B starvation of the nuclei of the cells. At all events the cell nuclei of animals dying of B deficiency take the ordinary nuclear stains very poorly or not at all and it is believed that the nuclei control cell nutrition.

Between the good health which, in animals otherwise properly fed, accompanies an adequate supply of vitamin B and the fatal termination which ensues on a totally insufficient quantity there is every gradation of impaired function on the part of the organs specially affected by the vitamin. This impaired function shows itself in man by a multiplicity of ills which are commonly looked upon as 'functional' diseases because most of them have not yet come to be considered within the domain of the operative surgeon and the histological damage when observed *post mortem* is attributed to germs or to climatic conditions: to anything in fact except the faulty material with which the body is supplied for its delicate metabolism. The consequences of the deficiency are protean in their manifestations. In the digestive tract the impaired nervous and muscular tissues are unable to perform their functions properly. Rowlands has shown by X-ray photographs of rats that enormous dilatation of the stomach occurs in B deficiency. He also demonstrated the presence of bacteria in the villi of the intestine of these animals under the same condition and inclines to the view that the absorption of toxins from this source is one of the causes of rheumatoid arthritis and chronic rheumatism.

In the nervous system every degree of 'functional' neurosis is manifest at one end of the series with beri-beri and paralysis at the other end. The effects upon the circulatory and endocrine systems are too multiplex to deal with in a short article such as this. The question is often asked of how much of the foods containing the different vitamins are needed for healthy nutrition and only in connection with vitamin B are we able to answer the question to some extent. Plimmer, Rosedale and Raymond have made a long series of laborious experiments on this subject and their findings are summarised fully in the *Bulletin of Hygiene* (February, 1928).

They find that the amount of vitamin B required varies according to the calories of the diet, whether those calories are furnished by carbohydrates, fats or proteins. They suggest the formula

$$\frac{\text{Vitamin B}}{\text{Calories}} = \text{a constant.}$$

That is to say that the more food a man consumes the greater is the amount of B required, and an impartial and unerring justice pursues the glutton.

In the case of growing children and young animals the above proportion must be increased but still remains a constant.

Another interesting point is mentioned in their paper in which they suggest that owing to the impaired digestion which ensues when B is deficient the absorption of the other vitamins is interfered with and the condition of the animals is complicated by the results of this secondary deficiency.

In conclusion we are, I think, entitled to assume that it is proved that an immense amount of illness and impaired vitality results from the vitamin B deficiency in the diet of all classes. This diet, in the tropics especially, consists of a great excess of sugars and starchy foods which have been for the most part carefully deprived of vitamin B in the processes of commercial refinement. Much of the little that the refiners have left is destroyed by the cook and as a result my own profession flourishes exceedingly. Besides this artificial shortage of vitamin B there is too small a consumption of green vegetables and fresh fruit which might make good the loss in some measure.

As I remarked in my first article I must leave the solution of the tangled problems involved to my friend the economist.

(*To be concluded.*)

MAURITIUS DRIED LITCHIS.

THE litchi, letchi or lychee (*Litchi chinensis* Sonn. = *Nephelium Litchi* Gamb.), is a small to medium-sized tree belonging to the natural order Sapindaceae. It is a native of South China and is largely cultivated in that region for the sake of its fruit, which is highly esteemed. Although considered most attractive when fresh, fairly large quantities of the fruit are exported from China in the dried state and some, preserved in syrup, reach the United States. The plant has been introduced into many other parts of the tropics, including India, Australia, South Africa, West Indies and Brazil.

In Mauritius the litchi has been found to thrive exceedingly well. There are already many thousands of bearing trees in the Colony and the number is increasing at the rate of about 200 to 300 per year. Owing to this rapid increase it is anticipated that in due course the supply of fruit may exceed the consuming capacity of the Colony. The fruits are egg-shaped, varying from 1.25 to 1.6 in. in length and from 1.0 to 1.25 in. in diameter. The shells are pale reddish-brown, thin and brittle and covered with small wart-like protuberances. The pulp of the fruit is soft, dark reddish-brown and somewhat shrivelled, and is attached to a tough skin which covers a large, hard, chocolate-coloured seed. The skin, with the pulp attached, can be easily peeled off the seed. The pulp has a pleasant, raisin-like taste.

It is believed that the dried litchis would find a market in the United Kingdom.—(*Bulletin of the Imperial Institute*, Vol. XXVI, No. 4).

SIERRA LEONE GRASSES.

The Palatability of Possible Pasture grasses in Sierra Leone.

BY D. C. EDWARDS, B.SC.,
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Sierra Leone.

THE aims of this investigation are to decide what grasses the animals eat, and what preferences they show for particular grasses. This is considered essential as the first step in determining the possibilities of establishing pastures in Sierra Leone. Little is known about the grasses of the country, and it will, of course, be necessary to determine their behaviour under grazing conditions in both the Wet and Dry Seasons, their influence one upon another under these conditions, and their respective nutritive values, but obviously we must know what the animals eat before chemical analyses and other investigations are undertaken.

The experiments were carried out in connection with sheep, and the results therefore, do not necessarily apply to other animals. It is hoped to make similar tests with cattle in the near future.

Usual Management of the Sheep.

The sheep are let out daily at 7 a.m. and turned in at about 5 p.m. For obvious reasons the animals cannot be left out at night. They are taken to different waste areas where there is grass, and allowed to roam at will, with a man in charge to prevent straying on to farm crops.

Method.

There are no enclosed areas, and fencing material is not at present available, so a method had to be devised to suit these conditions. The sheep had been obtained from native owners, who had kept them more or less under domestic conditions (1), and they were therefore quiet and easy to observe closely in the field.

Three sets of direct observations were made:

(*a*) Observations were made on ten sheep over one month to determine what grasses and other plants the animals fed on. Native (Mende) and ordinary English names were used, and specimens collected for identification. The information obtained was made use of in the subsequent sections.

(*b*) Observations were then made at three separate periods in August. At these times (2) three sheep were followed and closely watched, and the time spent in feeding on each different type of plant was noted. The same three animals were observed throughout. At the end of each period the total time spent feeding on each type of plant and the total time not feeding were obtained. The periods were as follows:—

1.—7 a.m. (when first turned out) to 12 noon.
2.—12 noon to the time the animal ceased feeding for the day, the sheep having grazed freely during the earlier part of the day.
3.—Throughout a day, from the time of being turned out at 7 a.m. to the time the sheep ceased feeding.

The data collected for the three periods are set out in Table I, and the figures represent

(1) *i.e.* : actually in or about the house.
(2) The sheep were a ram, a ewe and a wether.

TABLE I.

Showing relative palatability as percentages of available time devoted to each plant (average for three sheep.)

	Preference Figures.		
	Period 1.	*Period* 2.	*Period* 3.
GRASSES.			
Axonopus compressus (Yani)	31.14	30.69	25.47
Melinis minutiflora (Efwatakala)	12.58	6.72	11.01
Rottboellia exaltata (White Ngongoi)	11.90	6.42	8.77
Pennisetum gracile (Red Ngongoi)			
Paspalum scrobiculatum (Kapieh)	2.50	2.28	2.26
Cynodon dactylon (Dhub Grass)	1.78	2.74	1.39
Sporobolus pyramidalis (Tolugbele)	1.83	—	0.17
Imperata arundinacea (Lalang)	—	0.75	—
OTHER PLANTS.			
Commelina sp. (Kpagoi)	11.94	6.04	6.22
Passiflora foetida (Tombomakeh)	3.24	—	2.65
Not identified (Bengal Bean)	2.56	3.21	1.79
Ipomoea batatus (Sweet Potato)	1.16	—	—
Ipomoea digitata (Hokeyuwie)	1.14	9.73	8.70
Ficus sp. (Ndahi)	0.33	—	—
Desmodium lassiocarpum (Namai)	0.23	0.57	0.20
Morinda sp. (Yumbuyambeh)	—	1.17	1.64
Not feeding	16.33	28.53	29.34

percentages of the available time devoted to the various plants eaten.

The area chosen for this part of the work was a young (3) banana plantation of roughly two acres, on which were found most of the grasses the sheep had been observed to eat. The herbage on the area is kept fairly short by cutlassing, and therefore most of it was at a young stage of growth, with the exception of Efwatakala Grass which had been allowed to grow tall. A rough survey of the plants present was made. (*See* Appendix.) It is significant that throughout the whole time when the sheep were observed in the field they showed practically no tendency to stray from this area, although all round there was an abundance of herbage, which was, however, more mature. During the experiment 11 sheep and a lamb fed on the area.

The times when the sheep ceased feeding were chiefly during heavy rain, and in the hottest part of the day.

(*c*) The grasses the sheep had been observed to eat throughout the whole of the previous part of the investigation were presented to the same three sheep dealt with in (*b*). The fresh cut grasses were placed in baskets and a separate experiment was carried out for each animal. The baskets were numbered to facilitate the taking of notes, and the order was changed for each sheep to prevent error arising from some baskets being easier of access than others. Each sheep was observed for a period of approximately two hours, as it was felt that if a longer time had been allowed the grasses may have wilted to too great an extent. The time the animals devoted to eating each grass was recorded, and the time not feeding. After each experiment the condition of the contents of the baskets was observed, and those which had been left untouched or very little disturbed, noted. The results are set out in Table II.

TABLE II.

Figures as percentages of available time (average of three sheep).

Grass.	*Preference figures.*	*Appearance of baskets after experiment.*		
		Sheep 1.	*Sheep* 2.	*Sheep* 3.
Axonopus compressus (Yani)	22.78	much disturbed	much disturbed	much disturbed
Melinis minutiflora (Efwatakala)	14.65	do.	do.	do.
Rottboellia exaltata (White Ngongoi)	10.06	do.	to some extent	do.
Setaria sulcata (Mbowi)	9.50	do.	much disturbed	do.
Pennisetum gracile (Red Ngongoi)	4.36	do.	do.	do.
Cynodon dactylon (Dhub Grass)	1.89	to some extent	do.	untouched
Sporobolus pyramidalis (Tolugbele)	1.35	little disturbed	do.	do.
Schizachyrium brevifolium (Ngokapui)	1.24	to some extent	to some extent	to some extent
Paspalum scrobiculatum (Kapieh)	1.16	little disturbed	do.	untouched
Imperata arundinacea (Lalang)	0.19	untouched	little disturbed	little disturbed
Eleusine Indica (Ngetewuli)	0.16	to some extent	untouched	do.
Not feeding	27.91	——	——	——

Observations and Conclusions.

As previously mentioned it was noted that the sheep showed practically no inclination to stray from the area utilised for the second part (*b*) of the investigation. This is in accordance with what has been observed in Britain, viz.: that sheep show a marked preference for immature grasses. Yani (*Axonopus compressus*) was preponderant in the area, and this has been noticed in a number of cases where grass has been kept cut short. It would appear that constant cutting favours Yani, and grazing would probably have a similar effect. It was noted throughout that the sheep preferred the leaf to the stem of the grasses (with the possible exception of Ngetewuli (*Eleusine indica*) where the flowering stems were eaten), particularly where there was much stem as in the case of the Efwatakala in the area. This fact had been observed previously during a folding experiment on young rice where the animals often ate the leaves and left the greater part of the rice stems standing.

(3) The sheep showed some tendency to eat banana leaves, but as far as possible they were prevented from doing so.

The main object of the investigation was to determine that preference sheep show for the various grasses, but figures showing their degree of preference for other plants are included in Table I, as it is thought that some of these plants may be useful as fodder. Two of the grasses tested are imported, Efwatakala (*Melinis minutiflora*) and Dhub Grass (*Cynodon dactylon*), the others are indigenous. There is a certain amount of confusion in the native names of *Rottboellia exaltata* and *Pennisetum gracile* which are called "White" and "Red Ngongoi" respectively. As the plants are of similar appearance in the field, it was not considered advisable to attempt to separate them in the observations in (*b*), they were however, separated in (*c*).

The figures are in striking agreement as to the preference shown for Yani and Efwatakala, the former being obviously the one most sought after of all the types in the herbage available. Ngongoi comes third in every case, and from the evidence of Table II it will be seen that it is probably the White Ngongoi (*Rottboellia exaltata*) which is preferred. Red Ngongoi

(*Pennisetum gracile*) comes fifth and well above most other grasses. In this table Mbowi (*Setaria sulcata*) is also amongst those for which a marked preference is shown. By reference to Tables I and II it will be seen that Dhub Grass (*Cynodon dactylon*) and Kapieh (*Paspalum scrobiculatum*), are eaten to some extent. As regards the former it is interesting to note that throughout the investigation sheep No. 2 showed an individual taste for Dhub grass. This may indicate that the taste is to some extent acquired. The figures for Lalang Grass (*Imperata arundinacea*) are possibly somewhat misleading, as at the time the experiments were carried out a considerable amount of it was flowering, and it may therefore have been more fibrous and less palatable than usual. This grass and Tolugbele (*Sporobolus pyramidalis*) were taken only to a small extent throughout the experiments.

The grasses most suitable for forming pastures are probably Yani, Efwatakala, and Dhub. It is difficult to say how White and Red Ngongoi and Kapieh would behave until they have been tested under grazing conditions, but it is thought quite probable that they may be useful. When kept short by mowing, Ngongoi appears to form a suitable herbage in association with Yani and Ngokapui. Mbowi although palatable, as far as my observations go at present, is mostly a shade grass, and also not likely to stand grazing. It may be useful to cut as fodder. One important point will be to find grasses capable of forming a pasture which will offer sufficient keep through the Dry Season. Unfortunately Yani gets badly burnt and White Ngongoi also to a large extent. It is interesting to note that Efwatakala is used for pastures in East Africa and is said to form a close herbage when grazed, and that Dhub Grass is considered very drought resistant and a good pasture grass either alone or mixed with other grasses.

Possibly certain leguminous plants other than those mentioned as having been eaten, may be valuable, and further tests in this direction should be made. *Desmodium triflorum* grows well in association with Yani and other grasses, but the sheep were not observed to eat it during the field experiments, and only took it to a small extent during subsequent observations.

It is hoped this work will serve as a preliminary step to other important investigations on the behaviour of the various grasses under grazing conditions at different times in the year, particularly in the Dry Season. It is also possible and even probable that in other districts there are promising grasses to be found which do not grow here, but the results obtained at least provide something to work upon. It is intended to extend the investigation on more comprehensive lines when fencing material is available.

Mr. F. C. Deighton, M.A., kindly identified the plants which it has been possible to name, and four agricultural apprentices were of great assistance in carrying out observations on the sheep.

APPENDIX.

Grasses and other Plants Present.

Native Name or Common English Name.	*Technical Name.*	*Family.*
GRASSES.		
Yani	*Axonopus compressus.*	Gramineae.
Kapieh.	*Paspalum scrobiculatum.*	do.
Tolugbele.	*Sporobolus pyramidalis*	do.
Lalang.	*Imperata arundinacea*	do.
Dhub.	*Cynodon dactylon*	do.
Efwatakala.	*Melinis minutiflora.*	do.
White Ngongoi.	*Rottboellia exaltata.*	do.
Red Ngongoi.(4)	*Pennisetum gracile.*	do.
OTHER PLANTS		
Nanai.	*Desmodium lasiocarpum.*	Leguminosae.
Koli-niki.	*Desmodium triflorum.*	do.
Njeipai.	*Cassia* sp.	do.
Gbangbeh.	*Cassia sieberiana.*	do.
Kpakei.	*Albizzia brownei.*	do.
Ndandei.	*Dichrostachys nutans.*	do.
Bengal Bean.	—	do.
Not identified.	—	do.
Fogolei.	*Spermacoce ramisparsa*	Rubiaceae.
Yumbuyambeh	*Morinda* sp.	do.
Toteingei.	*Oldenlandia lancifolia.*	do.
Sweet Potato.	*Ipomoea Batatas.*	Convolvulaceae.
Hokeyuwie.	*Ipomoea digitata.*	do.
Ndondokoi.	*Ipomoea involucrata.*	do.
Gikpoi.	*Emilia sonchifolia.*	Compositae.
Ngugbeh.	*Ageratum conyzoides.*	do.
Njahewei.	*Mariscus umbellatus* and *Kyllinga* sp.	Cyperaceae.
Njeiwei.	*Scleria racemosa.*	do.
Njikoi.	*Alchornea cordifolia.*	Euphorbiaceae.
—	*Euphorbia aegyptaca*(?)	do.
Banana.	*Musa sapientum.*	Musaceae.
Tombomakeh.	*Passiflora foetida.*	Passifloraceae.
Kpagoi.	*Commelina* sp.	Commelinaceae.
Ndahi.	*Ficus* Sp.	Moraceae.
Ndogboyengei.	*Waltheria lanceolata.*	Bombacaceae.
Kandi.	*Anisophyllea laurina.*	Rhizophoraceae.
Honawai.	*Clerodendron scandens.*	Verbenaceae.
Mbuie.	*Smilax kraussiana.*	Liliaceae.
Kpokoyangoi.	*Periploca nigrescens.*	Asclepediadaceae.
Ndopaneh.	*Tetracera potatoria.*	Dilleniaceae.
Nyamawai.	*Cnestis ferruginea.*	Connaraceae.
Mbeli.	*Haronga paniculata.*	Guttiferae.
Ginger.	*Zingiber officinale.*	Zingiberaceae.
Toanyeh.	*Ochthocosmus africanus*	Linaceae.
Helui.	*Sida carpinifolia.*	Malvaceae.
Ngolotawai.	*Physalis angulata.*	Solanaceae.
Njamandeh.	*Phaylopsis parviflora.*	Acanthaceae.
Tawa-bimbeh.	*Dioscorea* sp.	Dioscoraceae.
Ndopa-yeingei.	*Melochia melissaefolia.*	Sterculiaceae.

NOT IDENTIFIED.

Yambasui, Kpakuwuli, Tijoi, Koprehui, Yingoi, Fokobei, Mbagalei, Togeingei, Ndumulai, Kamajovondoi, Ngayanyangobalah, Seimei Pomamagbeh.

(4) The inflorescence is called "Gbanalevui" (Mende).

THE PRINCIPAL'S REPORT, 1927-28.

(*Concluded.*)

[*Copies of the Prospectus for* 1929-30, *the Principal's Report for* 1927-28 *and the Register of the Imperial College of Tropical Agriculture may be obtained on application, from the Secretary, Imperial College of Tropical Agriculture,* 14, *Trinity Square, London, E.C.* 3., *or from the Registrar, Imperial College of Tropical Agriculture, Trinidad, B.W.I. For the convenience of readers extracts from the Principal's Report for* 1927-28 *are published below.*]

Progress of Research during the year.

Cacao.—A definite scheme for biological research into this crop has been adopted by the College based on a memorandum by Professor Cheesman. This will involve the acquisition of an estate and the provision of additional staff in the shape of a physiologist and geneticist. It is hoped to make a start next year as funds become available. In the meantime, two post graduates have been prosecuting an enquiry into the physiology of fruit setting in cacao and have obtained some interesting results.

Cotton.—Research on this crop naturally now devolves on the Empire Cotton Growing Corporation's Research Station which is near by. Stock lines and selections are, however, kept on, and some 250 single plant samples were collected. Work in both the Agricultural and Botanical Departments on this crop largely resolves itself into reservation of material suitable for students problems.

Tobacco.—Various types were grown and cultivated and irrigation methods demonstrated, but the work was chiefly in connection with the instructional side of the College.

Citrus.—It was not found possible to do any more research work on this crop as staff and funds are not yet available, but the collection of limes and citrus sent from Burma are being grown.

Coconuts.—Work on the cytology of the coconut has not been continued since preliminary work indicated that it would be a better policy to postpone further investigations pending the exploring of the desirability of seriously embarking on these problems here at all, for it is perhaps doubtful whether Trinidad is the best centre, and probably work of this nature could more conveniently be carried out at a Research Station in the Eastern Tropics.

Jute.—Further trials were made, but as it is obvious that this crop, for economic reasons, is not likely to become an important one in this area, in future, small areas only will be grown for instructional purposes.

OTHER CROPS.

A good deal of attention is being paid to testing varieties of green crops which may prove useful to cane planters and farmers not only by resting the land from sugar-cane, but also by bringing in some return in the shape of stock food, and so saving the existing large importations from abroad. The most promising of these is the Bengal baen (*Stizolobium*), and further genetic studies on this crop have been carried out. Attention is being paid to the breeding of a type with a bush habit of growth.

Attention has also been paid to the soy bean, and selection work in the most promising variety tried has been commenced. Other crops that have received some attention are maize, sweet potatoes, coix and sesamum, and the improvement of these crops will be a continuous matter. Various types of cover crops suitable for both orchard and field crops have received trials. *Crotalaria usamoerensis* and *Calopognium* both show promise of being suitable to West Indian conditions.

Soil Investigations.—Much time was devoted to an examination of soils in the cane growing areas, and a considerable accumulation of knowledge, that is not only of scientific value, but has in addition led to practical results in the field, has been accumulated. Previous investigation had indicated that the lime content of the soil had something to do with the resistance of the sugar-cane plant to froghopper blight. This year's work has confirmed this opinion, and has shown that an important factor is the proportion of adsorbed calcium ions present. Methods for determining the "lime requirements" of soils have been standardised, and methods for expressing soil texture by a single value index have been devised. This method has proved of considerable service in classifying and plotting on maps the 3,500 soil samples so far obtained from the soil survey of the cane area of Trinidad. The practical result of these researches is that the College is now in a better position to advise cane growers with regard to the amount and kind of lime to supply to their soils in particular fields, and the methods of application to be employed.

It has been found possible to resume the study of laterite soils, and indications have been found that certain of the peculiar characteristics of these soils are due to the alumina-silica ratio.

Mycology.—The study of coconut diseases was continued by the Professor, and much work was done on the so-called "Coconut wilt" disease. It has been shown that trees in this condition are not affected by any definite organism, but are suffering from what is really a physiological drought. The work is still continuing, and is likely to have far-reaching economic results, since the so-called "wilt disease" is very prevalent in parts of the Caribbean area.

Another line of research consists of a comparative study of *Phomopsis* spp. made from "Die-back" tissue of cacao, lime and rubber in

the West Indies. Also the physiology of the parasitism of *Macrophomina phaseoli*, a fungus which has been found associated with limes in the so-called "red root" disease of that crop (a cause of serious losses in Dominica) and also on cotton, tobacco, soy and other crops, requires study.

A preliminary survey of the American leaf disease (*Viruela*) on Arabian coffee has been made, and further investigations will continue. Incidentally, this disease has also been noted on Robusta coffee.

Entomology.—Mr. Urich has undertaken new investigations into the life history and habits of *Castnia licus* and *Diatraea saccharalis*, both of which are serious "borers" on cane. Some work has also been done on the Mole cricket, *Laphygoma frugiperda*, and on trials of insecticides.

Mr. T. H. C. Taylor, an entomologist of the Fiji Agricultural Department, spent five months at the College for the purpose of studying and collecting certain coccinellid beetles that are predaceous on coconut scale (*Aspidiotus destructor*). He was given all laboratory assistance, and it is satisfactory to record that he was able to breed and transport successfully to Fiji (after a five weeks' passage by sea), five species of this beetle in sufficient numbers for his purpose. The thanks of the Government of Fiji have been conveyed to the College for assistance given in this work.

Hygiene and Tropical Agriculture.—Thanks are due to the Director of Medical Services in Trinidad for affording accommodation and facilities to the Professor in charge of this department. This gave the Professor the opportunity of pursuing his investigations on nephritis, and into the various types of malaria and filaria and the problems that arise from their prevalence. His services were lent for several weeks to Barbados, and the thanks of the Government of that Colony were given to the College for his valuable work in connection with an outbreak of malarial fever that occurred there.

Economics.—A survey of the co-operative movement has been made, but not published, for Trinidad and Tobago, St. Lucia and British Guiana. An economic survey of the Cacao Industry in Trinidad has been completed by Professor Shephard, and a similar survey of the Sugar Industry in the British West Indies is in course of preparation, together with correlative studies of Sugar Factory data. Other lines of work are an enquiry into the cause of indebtedness among peasant proprietors on sugar estates. Major lines of research in the future will be, firstly, the economics of peasant and estate agriculture, and, secondly, estate accountancy, as an end to more efficient agriculture. Mr. G. Wright, the Lecturer in Economics, has been awarded the degree of Master of Commerce of the Leeds University for a paper he presented, entitled "An Economic Survey of St. Vincent."

Sugar Technology.—Good progress has been made during the year. The methods of production of a high grade syrup direct from cane juice have been investigated, and the details have now been worked out and applied on a factory scale. This syrup would appear to be specially suited for the American and Canadian markets. The method now standardised should prove of particular value to some of the small sugar factories in the Caribbean area. Experiments in the manufacture of white sugar direct from the juice indicate that it is not possible to produce by this means a white sugar equal to refined sugar.

A good deal of work has been done on methods of juice clarification. For the production of Demerara crystals it is indicated that the best results are obtained by liming the juice and sulphiting the syrup.

Other important lines of work that are under investigation are the trial of hot versus cold liming and the clarification of syrup and molasses by centrifugal methods.

Scientific Papers.

The following papers have appeared during the year, and in addition, numerous shorter notes and articles have been published both in *Tropical Agriculture* and the *Proceedings of the Froghopper Investigation Committee* as the result of the investigations made by the different departments of the College.

BOTANY DEPARTMENT.

1. Natural Crossing and the Genetics of Axil Spot in Cacao. S. C. Harland and G. E. Frechville, *Genetica*, Vol. IX, p. 279.
2. Genetic Studies in *Ricinus communis*. L. J. E. Peat. *Journal of Genetics*. May, 1928, p. 373.
3. Banana Research at the Imperial College of Tropical Agriculture. E. E. Cheesman. *Agenda memo. 11 of the Imperial Agricultural Conference.*

CHEMISTRY AND SOIL PHYSICS DEPARTMENT.

1. An Index of Soil Texture. F. Hardy. *Jour. Agric. Sci.*, Vol. XVII, No. 2, April, 1928.
2. An investigation of the method of Page and Williams for the Determination of the Saturation Capacity of the Soil. P. E. Turner. *Jour. Agric. Sci.*, Vol. XVII., No. 2, April, 1928.
3. The Slaking of Dry Soils with Water. K. T. Hartley. *Jour. Agric. Sci.*, Vol. XVIII, No. 1, January, 1928.
4. Dye Adsorption. H. H. Croucher. *Jour. Agric. Sci.*, Vol. XVII, No. 2, April, 1928.
5. The Lime Status of Soil in Relation to an Insect Pest of Sugar-cane. P. E. Turner. *Jour. Agric. Sci.*
6. Liming as a factor in the Amelioration of Deteriorated Tropical Soils. P. E. Turner. *Jour. Agric. Sci.*
7. An Electrometric Method for Determining the Lime Requirements of Soils. F. Hardy and A. H. Lewis. *Jour. Agric. Sci.*

MYCOLOGY DEPARTMENT.

1. A Note on Green Muscardine (*Metarrhizium Anisopliae sorokin*). *Proc. Froghopper Investigation Committee*, Part IX. Trinidad and Tobago.

2. Root Diseases in the British West Indies and a Note on *Diaportha permuosa* (Marchal), or a closely related species. *Trop. Agric.*, Vol. V Nos. 4 and 5, 1928.
3. Wilt Disease of Coconut Palms in Trinidad. H. R. Briton-Jones. Supplement to *Trop. Agric.*, Vol. V, No. 5, May, 1928.
4. Observations on a Fungus Disease and on Insect Pest of Cotton. H. K. Hewison and J. E. Symond. *Emp. Cotton Grow. Review*, Vol. V, No. 1, pp. 48-53.
5. Some Conditions Influencing the Development of Bacterial Disease of Cotton (*Bacterium malvacearum*). W. P. K. Findlay. *Emp. Cotton Grow. Review*, Vol. V, Jan., 1928.

Economics.

An Economic Survey of the Cacao Industry of Trinidad. C. Y. Shephard. *Economic Geography*, Vol. III, No. 2.

Library.—With the help of additional staff and funds, work has progressed rapidly, and an average of about 40 volumes a week is now being sent to the binders. A start has been made in the purchase of back numbers of periodicals, standard works and new issues recommended by the heads of the various departments.

Cataloguing has also progressed steadily, and for the year ending 31st August, 1928, 2,300 books and volumes have been catalogued, 1,651 pamphlets, and 7,007 parts of journals have been received, and 1,122 books have been bound, and 207 books purchased, while 238 books have been presented.

In order to relieve congestion, double stacks of steel shelving have been purchased and installed, but it will be necessary to increase the Library space by absorbing several more rooms as soon as space becomes available on the completion of the new Chemical building.

The Sugar Factory.

The Experimental Sugar Factory was operated between 15th March and 24th May, during which period 1,272.65 tons of cane were ground, at the rate of 2.98 tons per hour of actual grinding time. 127.8 tons of sugar were made as against 93.56 tons in 1927.

The season was a much more favourable one than last year, and the cane was consequently richer and the juice of higher purity.

Canes for the factory were purchased from the Cotton Research Station, the College plots and the Government Farm, the average sucrose content being 13.09 and the average value of the cane per ton being $4.04.

Manufactured Products.—In order to give full instructional facilities to the students (who unfortunately are still few in number, only three having attended during the crop), practically every type of crystal sugar was manufactured, and in addition, two different grades of cane syrup, the total quantity manufactured being 800 gallons. The syrup experiments were most successful, and thanks are due to the British Suchar Processes, Ltd., who presented the necessary amount of carbon for the experiment, which commenced with the arrival of their Research Chemist (Mr. Farnell). The first batch of syrup made was of good quality, but showed a tendency to crystallise. In the second series of experiments, invertase was used for sucrose inversion with entirely satisfactory results. This syrup has been canned; some of it was sold locally and the rest exported to other West Indian Islands, Demerara, the United Kingdom, the United States, Canada and Newfoundland, with a view to getting the views of various markets. Very favourable comments have been received, and the results of these experiments are likely to prove of far reaching value to the West Indian Sugar Industry. The experiments will be repeated and the processes elaborated during the next crop season.

The following additional factory items of equipment were installed:—

(1) Molasses Tanks which were badly needed, as storage capacity was limited before.
(2) Motor Generator set.
(3) Induced Draft fan.

New Developments.

The Milner Hostel and the College Dining Hall, mention of which was made in my last report, were completed during the year. The Hostel has accommodation for 32 students and eight more can be accommodated in the house that was originally on the estate when purchased.

Another building which was completed during the year is the Power Station, at a total cost, including equipment and machinery, of about £4,500.

The swimming bath has now been completed at a total cost of about £100.

A small property, belonging to a Mr. Thorpe, adjoining College lands and comprising about 3½ acres, has been purchased. The larger part of the area has been cleared and planted with bananas for research purposes.

New Buildings.—Sanction was obtained to proceed with the construction of the new Chemical Block at a cost of £7,000. Steady progress was made and the building, which is a two-storeyed one constructed of reinforced concrete, will, when complete, house the departments of Chemistry and Sugar Technology.

The new building for the Low Temperature Research and Cold Storage plant was completed by the end of the year, and work on the installation of the interior fittings is now proceeding.

Plans are now being drawn up for the construction of an Agricultural Field Office, Store and Drying sheds.

Several minor alterations and additions, including the installation of an induced draught fan and new molasses tanks, have been made in the Sugar Factory. A sugar store and factory laboratory will be needed in addition in the near future.

Land.—Sanction was accorded to purchase about 10 acres of Crown land, adjoining the College area, for agricultural purposes, in addition to the 3½ acres acquired from Mr. Thorpe. The upset price of this land is $150.00 per acre.

Past Students.

Students who have passed through the Imperial College of Tropical Agriculture are now employed in the following parts of the British Empire :—India, The Union of South Africa, Swaziland, Southern and Northern Rhodesia, Tanganyika, Zanzibar, Uganda, Nigeria, The Gold Coast, The Anglo-Egyptian Sudan, Ceylon, Malay States, Iraq, British Guiana, Jamaica, Barbados, Trinidad, and Antigua and the Virgin Islands, as well as other Tropical countries outside the British Empire.

THE INTERNATIONAL INSTITUTE.

The foundation, nearly a century ago, of the International Agricultural Institute was a romantic episode in economic history. When David Lubin came to London and expounded, with volcanic volubility, his scheme for an agricultural information bureau which all the nations should support, and to which they should subscribe, he met with a courteous but cold reception. He was regarded as a visionary. He found none in this country to share his optimism or believe that his ideas were practicable. He proceeded to Italy and there with the assurance of an American prophet he presented himself to the King and persuaded him to take up his project. In less than three years the organisation was complete, some 70 nations had formally adhered to the Institute, signed the constitution, and appointed delegates to form collectively the permanent governing body. A large staff was collected and organised in four divisions, of which that concerned with statistics was the chief. Gradually the systematic supply of information as to the area and yield of crops and other particulars from the various adhering countries was arranged and the figures published in a monthly return. A year-book is compiled from time to time, the latest issued relating to 1927-8, which contains a mass of well-arranged tables giving for each country all the information about its agriculture which is capable of statistical expression. For purposes of reference these publications are invaluable to economists and statisticians. The Institute also published a periodical *Review of Agricultural Economics*, which contained important articles on the agricultural development, as well as on the agrarian legislation, of various countries. Recently the *Economic Review* and the *Statistical Bulletin* were amalgamated, and the *International Review of Agriculture* is now the official organ of the Institute, and includes the statistical data as well as a certain, though reduced, amount of economic information.—(*The Economist*, Vol. CVIII, No. 4, 455.)

CORRESPONDENCE.

The Editor, "Tropical Agriculture."

Dear Sir,

My attention has been drawn to the criticism by Dr. Harland on page 237 of *Tropical Agriculture*, Vol. V, of my analysis of the F_2 generation in a cotton cross. I would like to bring the following facts to my critic's notice :—

In the Indian cottons with which I have been working there is an astonishing uniformity of seed weight and fibre weight. The unit species which were the parents of the cross have the following seed and fibre weights :—

Name of the Cotton.	Ginning percentage.	Seed weight of 100 seeds.	Average weight of a hair (10-7 ozs.)	Remarks
Dharwar I (♀)	28	5.27±0.061	1.78	The fibre weight was determined at Dharwar by the Technological Assistant.
Rosea. (♂)	38	5.25±0.064	1.87	

If two of the factors in ginning percentage are thus for all practical purposes identical may we not take it that the difference in ginning percentage between the two cottons will be determined by the number of hairs on the seed and can this not be worked on as a simple factor for purposes of analysing the F_2 and the following generations ?

Yours faithfully,

G. L. Kottur,
Cotton Breeder, S.M.C. Dharwar, (Bombay, India).

Dear Sir,

Mr. Kottur's letter provides interesting data on Dharwar and Rosea cottons. What Mr. Kottur has shewn is that seed weight and possibly hair weight in the two types are phenotypically identical. If he could prove that all plants in F_1 and subsequent generations were genotypically identical for seed weight and hair weight, then certainly he could say that ginning percentage was determined by number of hairs per seed and could use it as a simple character. Even if it were a simple character it is still illegitimate to interpret a monomodal curve as indicating monohybrid segregation.

Yours faithfully,

S. C. Harland.

TROPICAL WORLD NOTES.

Gold Coast.

The Gold Coast Colonial Report No. 1418 for 1927-28 states that the Colony enjoyed remarkable prosperity, the total value of external trade during the year under review being £28,120,877 compared with £22,390,676 in 1926. Cocoa exports were valued at £11,727,566 and represented no less than 81.72 per cent. of the total value of exports which in 1927 was the highest on record. Although there was a decrease in export of 20,930 tons compared with the previous year, which was the highest annual export on record, the Gold Coast easily maintained its position as the premier cocoa-growing country in the world, producing about one-half of the world's supply. Prices were satisfactory throughout the year. The crop of kola nuts was about normal, but there was a decrease in maritime export of 986,716 lb. This decrease is ascribed to exports overland through the Northern Territories, of which no record is kept. The improvements in the oil palm industry has not been maintained, exports having fallen by 1,776 tons compared with 1926. Although merchants are willing to buy at a fair price, the quantity of oil offering is small, greater attention being paid to products which are easily prepared for market. Increasing quantities of palm oil are reported to be used for domestic purposes in the place of the cheaper kinds of lard substitutes. There is a well-established coconut industry in the Keta District. There was, however, a slight falling off in the export of copra. The output of the Government sisal factory near Accra was 135 tons of fibre in 93 running days as against 459 tons in 274 running days during the previous year. Unfavourable weather conditions accounted for this large decrease.

* * *

Barbados.

The Barbados Colonial Report No. 1422, for 1927-28, states that during the year under review the sugar crop, owing to favourable weather conditions, was a good one. The total trade of the island in 1927 was £3,881,774 with imports valued at £2,278,243 and exports at £1,603,531. According to Customs returns for the year 1927, 50,220 tons of vacuum-pan sugar crystals, 2,885 tons of muscovado sugar, and 8,258,690 wine gallons of molasses were exported. The total number of acres planted in cotton for the season 1926-27 was 3,526, and the approximate total yield was 787,394 lb. of seed cotton, the general yield of the island being 223 lb. seed cotton per acre. The lint percentage obtained was 24.3, the yield of cotton seed 576,766 lb., and the yield of lint 191,337 lb., the loss being approximately 19,291 lb.

Siam.

Mr. W. W. Coultas' Trade Report on the Economic Conditions of Siam for 1928 states that it is as a producer of rice that Siam takes her place in the world's markets and this article accounts each year for some 70 per cent. of her total exports. Since the disastrous season of 1919, when a sufficiency of rice for domestic consumption was only ensured by a total prohibition of export, steady progress has been made in irrigation projects, while public opinion generally is being educated not only to appreciate the benefits thereby conferred but also to interest itself in the value of fertilisers and the advantage of agricultural machinery. In addition to this, by encouraging the formation of agricultural co-operative societies in certain districts, the Government is making a laudable effort to improve the economic status of the cultivator by making him independent of the money-lender and thus enabling him to market his padi at the moment most favourable to himself. Recently, moreover, following upon complaints received from foreign markets of a deterioration from the standard of former years, the Siamese Government has interested itself in research having for its object the improvement and standardisation of the grain. Although it is still doubtful what measure of success can be obtained in this direction, it is nevertheless a sign of the times that millers are beginning to concern themselves in such matters under Government encouragement. But the most significant economic fact of latter years has been the stimulus to increased rice production afforded by the steady development in railway communications. Under this stimulus cultivators in remote regions have been encouraged to plant for more than the supply of their own personal and local needs, and the additional amount of rice thus made available for export is being reflected in the outward trade figures. As a result not only is the wealth of the country being increased but it is also being more widely distributed. A noteworthy development consequent upon the opening up of new areas to padi-cultivation has been a decentralisation of the rice-milling industry, which was previously confined to the capital.

* * *

Cyprus.

Plants of sisal and Mauritius hemp recently imported into Cyprus from Sierra Leone are reported to be doing well in the Government Nurseries. They will be planted out in March next, and it will be interesting to see whether Cyprus will become a supplier of rope-making fibre, of which Great Britain alone consumes over 100,000 tons per annum. Citrus fruit plantations are expected to extend rapidly, stimulated by the interests now taken in oranges and lemons by the larger British houses. Limes have now been introduced from Sierra Leone with the view of starting a local concentrated lime juice industry. (*The Chamber of Commerce Journal*, Vol. LVI, No. 776.)

REVIEWS.

The Soils of Cuba. By Hugh H. Bennett and Robert V. Allison. *Tropical Plant Research Foundation*, Washington, 1928. Price 31*s*. pp. 410.

This account of the soils of Cuba, together with a soil map, is the outcome of a joint project between the United States Bureau of Soils and the Tropical Plant Research Foundation, aided by the Cuba Sugar Club of Havana. Its object is to aid in the planning of investigations into sugar-cane production, and to extend the knowledge of tropical soils. The arrangement of subject matter is simple. In an introduction, special mention is made of the frequent misleading appearance of forest lands as regards their suitability to cane cultivation, and the need of detailed soil investigations in these regions. In Chapter II, the general soil characteristics of Cuba are described. Mention is made here of the remarkable Matanzas red lateritic soil, which occurs extensively in Cuba, and has no counterpart in the United States of America. This mature soil contains a high proportion of clay, yet it is free draining, very deep, and highly productive. At the other extreme from this red friable soil, are grey siliceous clays, noted for their stickiness, imperviousness and lack of depth. In addition to these contrasted clay types, certain loose sandy soils occur in Western Cuba in the Isle of Pines, and on savanas in other parts of the territory. Certain of these soils have their counterparts in the coastal plains of south-eastern United States of America. They appear to be of detrital and colluvial origin.

Many of the soil types of Cuba are characterized by the occurrence in them of roundish ferruginous concretions, of size varying from that of a man's fist to microscopic dimensions. They are known as perdigon, and are doubtless due to segregation of iron oxide around nuclei within the soil. Their presence in soil lessens its fertility and increases its porosity.

In Cuba, four distinct kinds of sub-soil exist. The first is the Matanzas type, which is very deep and free-draining. It may be tilled to almost any depth, and at any time of the year, even during rainy weather. The second kind of sub-soil, that of the Truffin soil family, is hard and impenetrable. Unless broken by chiselling or knifing with suitable tractor-implements, it inhibits satisfactory cane growth. The third kind, that of the Bayamo soil family, is a dense plastic clay, which defies all attempts at improvement by tillage. It runs together markedly on wetting. Cultivation of this soil-type is usually not profitable, and it is advised that such land be abandoned. Close ditching alone seems to give any benefit. The fourth sub-soil type is that underlying the Limones soil family. It is also clayey and intractable. Ploughing deeper than ten inches is not recommended for this soil, since the raw upturned material causes injury to crops. Organic matter is seriously lacking in it, and improvement follows its incorporation into this soil.

For convenience of description, the soils of Cuba are arranged in families, depending chiefly on their structure. The families are then divided into series, the grouping being decided by the kind of profile which the soils exhibit in vertical section. Series are next divided into classes, depending on the mechanical composition of the soils. Finally, classes are divided into soil-types, which are the actual units used in field mapping.

In the third chapter of the book, the seventeen soil families represented in Cuba, are described in detail under separate soil series headings in the following manner. The first family comprises the permeable, naturally well-drained soils, whose profiles are uniform in appearance down to the parent rock. It consist of four series, of which the red Matanzas soil is a typical example; the second family comprises shallow clay soils over-lying basic igneous rocks, and showing a characteristic three-layered profile; the third family includes soils with very hard clay sub-soils, and so on, for each of the seventeen families in turn.

In Chapters IV, V, VI and VII (200 pages), the different geographical regions of Cuba are considered, with regard to topography, physiography, soils and agriculture, with particular reference to sugar-cane.

In Chapter VIII, the salt soils of Cuba are described; in Chapter IX, the results of some soil moisture studies are presented; in Chapter X, the climate of Cuba is discussed, and the relation of soils to agriculture is considered in Chapter XI.

The last chapter, Chapter XII, on soil classification, is from the pen of Dr. C. F. Marbut, Chief of the Soil Survey Division of the United States Bureau of Soils. It describes the principles on which the modern classification of soils is based. A glossary, several tables and maps, complete this extremely interesting book.

The reviewer has no hesitation whatever in recommending Bennett and Allison's "Soils of Cuba" to all who believe that the fundamental source of agricultural wealth lies in the soil, and that it is on a thorough study of soils that progress in field practice must ultimately depend.

F. H.

SCIENCE PROGRESS.

The College Library has the following duplicate volumes of *Science Progress* for sale:—Nos. 1 to 52, with the exception of No. 18, and Nos. 56, 67 and 77. These may be obtained on application to the Librarian at the reduced price of 2*s*. 6*d*. per copy exclusive of postage.

INDIA IN 1927-28. By J. Coatman, Director of Public Information, Government of India. Calcutta; *Government of India Central Publication Branch.* Price Rs. 2-8 or 4*s.* 6*d.*

A useful book of reference for students of the Indian situation illustrated with maps, photographs and diagrams.

As a preparatory note is careful to explain, it must not be understood that the approval either of the Secretary of State or of the Government of India has been extended to every particular expression of opinion transcribed by the author.

A compact and lucid account is given of conditions generally in India during the year under report and the state of commerce, finance and trade is particularly instructive. A brief account of the political situation is given, and naturally a whole chapter is devoted to the progress of the Indian Statutory Commission.

To the agriculturist, the chapter entitled "Country and Town" is of particular interest, since details are given of the work of the agricultural departments and their efforts at introducing improvements. Some of their successes have been marked, particularly in the introduction of improved seeds of various staple crops, notably cotton, wheat, rice and jute. The progress made in the introduction of new varieties of canes raised at the Central Indian Cane Seedling Station at Coimbatore is also satisfactory. The account of new irrigation works in progress or nearing completion makes fascinating reading and is a tribute to the wonderful work of the engineers of the Indian Irrigation Service. The work of the Sukkur Barrage in Sind is making good progress and when completed will be one of the very largest and most ambitious schemes in the world.

The problem of financing the "ryot" is a perennial one and a clear account is made of the steady progress (in most Provinces) and, needless to say of the difficulties and obstacles that are facing the efforts made to introduce a co-operative credit system.

This volume is a creditable attempt to condense a very big subject into a compact volume for the use of those who are interested in Indian problems.

G. E.

* * *

NELSON'S WEST INDIAN READERS, Books IV and V. Compiled by J. O. Cutteridge. *T. Nelson & Sons, Ltd.*

Books IV and V complete the series of six books of West Indian Readers. Although emanating from Trinidad the West Indian outlook is so wide and comprehensive that there is not a child in any of the other colonies, be it Barbados, Jamaica, or British Guiana, that would not benefit by reading this extremely interesting and useful series. Even adults will find the perusal of these readers profitable, and, for the purpose of interesting children in the temperate zones in our tropical possessions, they have no rival.

C. Y. S.

THE COMPOSITION AND DISTRIBUTION OF THE PROTOZOAN FAUNA OF THE SOIL. By H. Sandon, M.A. *Oliver and Boyd,* Edinburgh and London, 1927.

This book brings together a great amount of information on the comparatively new branch of science which deals with the protozoa of the soil and presents it to the reader in an attractive form. It should be of great value to students of the subject, especially from the wide range of soils examined, the keys and tabulations provided and the extensive bibliography. The soil samples represent locations distributed throughout tropic and temperate zones and extending into Arctic regions, insular as well as continental.

Climate as such, within the range covered, appears to affect the occurrence of these micro-organisms but little, abundance of suitable food being indicated as the cause of abundance of protozoa in any region. All the soil protozoa appear to be world-wide in their distribution, the same species occurring in arctic, temperate, and tropical soils.

H. A. B.

BOOKS RECEIVED.

We have to acknowledge the receipt of the following books:—

ECONOMICS.

Year-Book of Agricultural Co-operation in the British Empire, 1929 (2 copies). Edited by the Horace Plunkett Foundation. *G. Routledge & Sons, Ltd.*, p. 476, 10*s.* 6*d.*

GENERAL.

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The Whip Snakes and Racers, Vol. I. A. H. Artenburger. *University of Michigan*, p. 248.

CHEMICAL NOTES.

Digestibility of the Components of Plant Cell Walls.

In *Die Naturwissenschaften* for 30th November, 1928 (See *Nature*, 26th January, 1929, p. 144), Dr. Max Rubner gives a general account of the physiological significance of the main components (pentosans, celluloses, and lignins) of the plant wall from the point of view of digestion experiments that were carried out in Germany during the War and the immediate post-War period. From this account, several conclusions of general interest emerge. In experiments upon animals and upon man, there was often a remarkable difference in the degree of digestion of cellulose material from the same food-stuff in different experiments upon the same subjects. Some of this difference may be due to difference in the bacterial flora of the intestinal tract, but the differences are so marked that Rubner concludes they point to the existence of many different forms of cellulose. As the same differences appeared when the purified celluloses from these food products are fed to animals, it does not seem possible to attribute them to the different extent to which the plant membrane is impregnated with fatty substances or lignins. Rubner discusses the wide variations in the methods used by different investigators to separate the lignin from the plant membrane, with the result that very different substances are probably included under this name. In any case it appears from the analysis of pentosans, cellulose, and lignin in a vegetable food material, before and after its passage through the mammalian alimentary canal, that in many cases a certain amount of the lignin fraction must undergo digestion. Whilst it is probably true that heavy lignification is associated with relative indigestibility, it would not seem safe to assume that the only constituent of a lignified plant wall to undergo digestion is any inner lining of pentosan character that may be present.

* * *

Molasses Distillation Residue as a Fertiliser.

The residue from molasses distillation contains organic nitrogen compounds such as glycocoll, analine, asparagine, aspartic acid, and a high proportion of carbon compounds. The fertiliser value of the residues will depend on the availability of the nitrogen contained in these compounds, that is, on the ease with which they are decomposed and their nitrogen ammonified and nitrified. If these processes do not occur readily, the nitrogen required by the bacteria decomposing the carbon compounds will be derived from that already present in the soil, and nitrogen starvation of plants result. Also, there is the possibility that the nitrogen during the decomposition of these compounds may be liberated in the gaseous form and be lost.

Samples of soil containing calcium carbonate were treated with these amino compounds, and other samples with molasses distillation residues. Determinations were made of the amount of amino compounds retained by the soils, the amount converted into ammonia, nitrite, and nitrate, and of the total residual nitrogen. Only small quantities of the compounds were retained by the soil after several hours contact. The nitrogen remaining in the soil was ammonified slowly, the nitrification process being more rapid. There was no liberation of nitrogen in the gaseous form.

The conclusions which can be drawn are that, if molasses distillation residue be used as a fertiliser on a soil containing calcium carbonate, there is a risk of losing the majority of the nitrogen by leaching before it is converted into ammoniacal compounds. All the nitrogen that is retained readily becomes available for the bacteria decomposing the carbon compounds contained in the molasses, and thus excessive denitrification is prevented.—(*Chem. Abs.* 22, 3945.)

* * *

The Germicidal Properties of Essential Oils.

The disinfecting and preserving powers of essential oils have been applied for centuries, but no systematic study and comparison of their germicidal strength has hitherto been made. Some workers have studied the effect of the vapours of the oils. It is now appreciated that contact between the liquid and the organism is essential before destruction can occur. An initial difficulty in making such comparisons is introduced by the insolubility of most essential oils in water. An emulsion must therefore be used. The germicidal power of an emulsion depends on the fineness of the suspension and on the surface tension between the emulsion and the suspending medium. Stable and uniform emulsions of suitable fineness were formed by dissolving the essential oil in B.P. paraffin and introducing the solution into water under controlled conditions. Moreover, the introduction of the oil into the paraffin lowered the surface tension at the water-paraffin junction. Absorption of the solution by the bacteria is thereby increased.

Comparative experiments on standard cultures of bacteria showed that the germicidal effects of those emulsions containing various essential oils were often greater than that of disinfectants in common use. Palmorosa oil, cinnamon leaf oil, and clove oil gave the best results.

Two interesting generalisations are suggested. Firstly, the germicidal power of an emulsion may be predicted by a measurement of the surface tension at the oil-paraffin solution and water surface. Secondly, the germicidal power of a chosen series of oils is approximately proportional to the percentage of one chemical constituent. Thus in the series mentioned above, their relative powers are approximately proportional to the percentages of eugenol they contain.—(*Perf. and Ess. Oil Rec.* 19, 285.)

The Editor requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

pH in Beet Sugar Factories.

A. J. RIJKEN (*Tijdschrift*, 1929, pp. 140-144), summarises three years' experience with pH control in a beet sugar factory. "Sulpho-orange" (La Motte) with a pH range of 11.0 to 12.6 and a colour change from yellow to orange was used in the first carbonation. Thymol blue was used with first carbonation juice, thin juice and thick juice; the range of this indicator is pH 8.0 to 9.6 and the colour change is from yellow to blue. A good indicator for thick juice—that is for the range 9.6 to 11.0—is still lacking. Trials were made with "nitro-yellow" (La Motte), which was found to be decolorised in solutions containing calcium salts; and with thymolphthalein, the colour of which disappears within a short time. La Motte's "purple" covers the range 9.6 to 11.2, but the colour changes at both the upper and lower range lack sharpness.

Tests were made which showed that the pH indication of sulpho-orange remained constant at all temperatures when first carbonation juice was warmed from 20° to 60° and cooled back to 20° again. When similarly tested on second carbonation juice, thymol blue showed a pH of 9.5 at 20°; as the temperature was raised to 60° the pH indication fell gradually to 8.5, and then as gradually returned to 9.25 as the temperature was lowered back to 20°. The same temperature effects were observed when this indicator was used with a thin juice.

The first carbonation juice was found to filter best at a pH of 11.4. The connection between pH and titrimetric alkalinity as CaO per 100 cc. was found to be as follows:—

Campaign 1927-28.

	Alkalinity.	*pH.*
1st carb. juice ..	0.079-0.119	11.2-11.5
2nd carb. juice ..	0.010-0.021	8.8- 9.5
Thin juice	0.016-0.019	9.0- 9.4
Thick juice (diluted 1 to 4) ..	0.148-0.058	10.5- 9.5

Campaign 1928-29.

	Alkalinity.	*pH.*
1st carb. juice ..	0.073-0.119	11.2-11.6
2nd carb. juice ..	0.013-0.022	9.2- 9.6
Thin juice	0.013-0.021	9.2- 9.6
Thick juice (diluted 1 to 4) ..	0.123-0.038	10.0- 9.3

The question as to the pH at which maximum removal of lime is effected in the second carbonation depends on the concentration of CO_3'' in the solution if the solution contains calcium in combination with acids that are weaker than carbonic acid: if the calcium is in combination with stronger acids, the presence of soda or potash is necessary in order that the equilibrium $Ca^{\cdot\cdot}$ plus $CO_3'' \rightleftharpoons CaCO_3$ may be displaced largely to the right. It was found that in most cases the minimum lime content—below 21 mg. per litre—was reached at a pH of 9.5 to 9.6, but where the minimum lime content was above 21 mg. the corresponding pH was 9.4 to 9.3. Low minima were observed mainly during the first half of the campaign, but later the minimum varied greatly, so that it was frequently necessary to add a quantity of soda in excess of the theoretical equivalent of the lime present. This is ascribed to the presence of organic acids having rather large dissociation constants. Such acids may be formed as a result of alterations in the stored beets, from decomposition of reducing sugars or by fermentation. Due to fluctuations in the pH of the juices at minimum lime content, the pH indications must be controlled by hardness tests with soap solutions; for obtaining good results it is necessary to make the soap solution with pure 50 per cent. ethyl alcohol. The pH of the juice has no influence on the foam formation in the soap test.—(*Facts About Sugar*, Vol. XXIV, No. 12, p. 275.)

* * *

Influence of starch on the manufacture of Sugar, and its removal from the juice.

E. Haddon (*Rev. Agr. Maurice* 5, 80-2 (1928)), points out that the trouble experienced with the juice from the Uba cane is due not to cane wax, as claimed by some, but entirely to starch and its hydrolysis products. The starch cannot be removed by carbonation. Filtration with kieselguhr removes it, but very large filtering surfaces are required. Better results are obtained with a diastatic enzyme, sold under the trade name of "Ubase." Its optimum activity is at pH 7.0 to 7.5, but the useful range is 6.5 to 8.0. It liquifies 2,400 times its own weight of starch in 30 minutes. The optimum temperature is 60 to 80°. The amount to be used is determined by the I test. The abnormal viscosity of the juice is entirely destroyed, and filtration becomes easy. The enzyme process may be combined with kieselguhr filtration.—(*Chemical Abstracts.*)

* * *

Formosan Sugar.

The Acting British Consul at Tamsui has informed the Department of Overseas Trade that the second official estimate puts the production of sugar in Formosa for the season 1928-29 at 11,941,540 piculs (about 705,000 tons) of centrifugals and plantation white, and 188,135 piculs (about 11,000 tons) of brown sugar, making a total of 12,129,675 piculs (over 716,000 tons). This represents an increase of more than 16,000 tons as compared with the first estimate, and of 2,462,058 piculs (over 145,000 tons) above the previous record of 1927-28. The estimate is based on conditions existing at the end of last year. The increase is attributed to the expansion during the year by over 30,000 acres of the area under sugar-cane, combined with the spread of superior varieties of cane and intensive methods of cultivation.—(*Chamber of Commerce Journal*, Vol. LVII, No. 780.)

CACAO RESEARCH.

Trinidad, showing approximate area under cacao. (By the courtesy of Economic Geography.)

VITAMINS.

Photograph by *Tucker Picture Co.*

Photograph of five pigeons simultaneously paralysed by a deprival of vitamin B. for a period of three weeks. (Govt. Path. Lab., Trinidad.)

IMPERIAL COLLEGE ASSOCIATION FOOTBALL CLUB, 1928-29.

Photo by *Tucker Picture Co.*

Standing : E. S. A. CHIN, A. E. TROTMAN, A. K. BRIANT, A. N. PRENTICE, C. W. LYNN, R. LEACH, C. G. AKHURST.

Sitting : A. W. F. SHEFFIELD, H. H. CROUCHER, F. R. SANDERS (*Captain*), J. M. WINGATE, J. WRIGHT.

IMPERIAL COLLEGE RUGBY FOOTBALL CLUB, 1928-29.

Photo by *Tucker Picture Co.*

Standing : PROF. H. R. BRITON-JONES, C. L. MACDOUGALL, R. D. BARNARD, J. DE LA BASTIDE, C. A. THOROLD, A. N. PRENTICE, A. C. MAHER, F. R. SANDERS, A. W. F. SHEFFIELD, A. S. THOMAS.

Sitting : W. B. HUTCHINSON, R. LEACH, R. H. FRASER, J. WRIGHT (*Captain*) R. G. H. WILSHAW, E. W. GADDUM, J. WEST.

SPORTS.

[*We publish below retrospects by Mr. J. Wright, Captain of the College XV and by Mr. F. R. Sanders, Captain of the College Association XI, of the* 1928-29 *Rugby and Soccer seasons. Photographs of the teams appear on page xii.*]

Rugby Football Club.

THE College Rugby Football Club is to be congratulated on another successful season. The prospects, owing to the dearth of backs, were at first not of the best, but with continual practice a team was formed which, though very variable in composition on account of injuries, produced uniform results, by dint of every member pulling his whole weight. The results achieved were as gratifying as they were unexpected. Of the nine matches played, all were won, the College making the high aggregate score of 121 points as against their opponents' 37. This constitutes a record and, further, the team had the satisfaction, by beating Demerara, of avenging last year's defeat.

In spite of an entirely successful season it cannot be claimed that the standard of play reached any high level, with the exception perhaps of the match played against the Southern Rugby Club on 24th November, when the College ran up 40 points, a score which, considering the state of the ball and the ground, would anywhere have been classed as excellent. The team was fortunate in having two games with the Navy and one with the French training ship, the *Edgar Quinet*. The games with H.M.S. *Durban* were characterised by their extreme keenness and that with the *Edgar Quinet* provided ample amusement for all those present, players and spectators alike.

The following played :—

Full Back :
A. N. Prentice.

Three Quarters :
R. G. Wilshaw, J. de la Bastide, F. R. Sanders, A. F. Sheffield.

Halves :
R. D. Barnard, J. Wright.

Forwards :
R. H. Fraser, R. Leach, E. W. Gaddum, J. West, W. B. Hutchinson, C. L. MacDougall, A. C. Maher, A. S. Thomas or C. A. Thorold.

The following took part in one or more games :—
Professor H. R. Briton-Jones, Dr. L. P. McGuire, A. K. Briant, G. G. Gianetti, R. Turner, J. M. Ward, C. G. Akhurst, D. L. Ferguson.

Appended herewith is a list of matches played :

Date.	Opponents.	Ground.	Results.
18th Oct.	Trinidad R. C.	Home	Won 10- 3
21st do.	Southern R. C.	Away	Won 14- 6
30th do.	Demerara	Away	Won 5- 3
16th Nov.	*Edgar Quinet*	Home	Won 8- 6
24th do.	Southern R. C.	Home	Won 40- 0
29th do.	Trinidad R. C.	Home	Won 9- 3
6th Dec.	Trinidad R. C.	Away	Won 9- 0
5th Feb.	H.M.S. *Durban*	Home	Won 13- 5
11th do.	H.M.S. *Durban*	Home	Won 13-11

Points for : 121 Against : 37

Association Football Club.

The season 1928-29 was fairly successful. The College XI entered for the Clydesdale Cup and the Football Association Trophy. They were defeated in the first round of the Clydesdale Cup, but reached the final of the Football Association Trophy which was lost 1-0.

The following played :—

Goal :
C. G. Akhurst.

Backs :
J. M. Wingate, A. N. Prentice.

Half-Backs :
A. F. Sheffield, F. R. Sanders, H. H. Croucher, J. Ward.

Forwards :
R. Leach, E. S. Chin, J. Wright, A. K. Briant, R. R. Follett-Smith, C. W. Lynn, A. E. Trotman.

The following matches were played :—

Date.	Opponents.	Results.
16th Oct.	Constabulary	Won 1-0
2nd Nov.	Sporting Club	Drawn 0-0
7th do.	Casuals	Won 2-0
25th do.	Trinidad Leaseholds	Lost 0-1
26th do.	Everton (Clydesdale Cup)	Drawn 1-1
30th do.	Everton (Clydesdale Cup) Replay	Lost 0-1
2nd Dec.	Q. R. C. (F. A. Trophy)	Won 3-1
4th do.	Constabulary (F. A. Trophy)	Won 3-1
9th do.	Trinidad Leaseholds	Lost 0-5
10th do.	Everton (F. A. Trophy)	Won 2-0
15th do.	Southern Casuals (F. A. Trophy—Final)	Lost 0-1
19th do.	Constabulary	Won 4-0
26th Jan.	Casuals	Lost 0-4
8th Feb.	H.M.S. *Durban*	Lost 2-4
9th Mar.	H.M.S. *Colombo*	Won 3-1

ACKNOWLEDGMENT.

WE have to acknowledge, with thanks, the gift of the following :—*The Caribbean Confederation*, C. S. Salmon, *How the Labourer Lives*, B. S. Rowntree and May Kendall, and *The English in the West Indies*, J. A. Froude, presented by the London School of Economics, and *Banding of Birds*, a collection of papers, collected and published by S. Prentiss Baldwin, presented by the collector.

COLLEGE NEWS.

Dr. C. Pratt sailed for England by the s.s. *Camito* on the 5th April.

* * *

The College is indebted to Mr. J. H. Taylor, Manager of the Trinidad Sugar Estates, Ltd., for his generous action in lending a tractor to enable certain newly acquired lands at the College to be brought into cultivation.

* * *

Mr. H. A. Ballou, Professor of Zoology and Entomology and Commissioner of Agriculture for the West Indies sailed for St. Vincent by the s.s. *Lady Nelson* on 26th March, and returned by the s.s. *Lady Hawkins* on 4th April.

* * *

It is gratifying to be able to announce that the Union Government of South Africa has consented to contribute £250 a year for the next five years to the funds of the Imperial College of Tropical Agriculture.

* * *

Sir Frederick Eckstein, Bart. whose name will always be connected with the Sudan Plantations Syndicate and the construction of the Makwar dam on the Blue Nile for the irrigation of the Gezira, visited the College and the Cotton Research Station on 25th March with his son, Mr. Bernard Eckstein.

* * *

Mr. J. M. N. Jeffries, the well known correspondent to the *Daily Mail* paid extended visits to the College on 23rd and 28th March. He displayed the keenest interest in all that he saw, and amongst other things inspected the College factory and some of the College experimental plots.

* * *

Professor R. C. Wood and five Cotton Corporation students left for Tobago by the s.s. *Belize* on 2nd March, and returned by the same opportunity on 6th March. They visited the island with a view to studying local conditions, peasant agriculture and the co-operative movement.

* * *

Amongst recent visitors to the College were: the Earl and Countess of Bradford, and Professor R. W. Reid of Aberdeen University, Dr. Thomas Barbour, Director of Museums and Professor of Zoology, Harvard University; Mr. T. Cadett, special correspondent to the *Times*, who attended the Standing Conference of the British West Indies that was recently held in Barbados.

Mr. R. R. Follett-Smith, Post-graduate at the College in 1925 who was on the staff of the Froghopper Investigation Committee and who was also attached to the College Department of Chemistry, has been selected by the Secretary of State for the Colonies as Chemist-ecologist for soil research in connection with the British Guiana colonisation and development scheme. We wish him all success in his new post.

* * *

The Principal accompanied by Dr. H. R. Briton-Jones and fifteen Colonial Office cadets, left Trinidad by the s.s. *Lady Nelson* on 26th March for St. Lucia and Barbados, where they spent the Easter vacation. An extensive touring programme was arranged for the party who remained in St. Lucia for five days and in Barbados for two days.

AGRICULTURAL EXCURSION.

A LARGE party consisting of the Principal, several members of the staff, and of Post-graduate students, visited the estates of the Usine Ste. Madeleine Company on Wednesday, 13th March. An early start was made to Harmony Hall, where tractor ploughing was in progress, and the value of this deep ploughing in relation to the cost per acre discussed. A new grading and drain making machine was also seen in action. The buffalo herds both here and at Cedar Hill were inspected, and the relative merits of Indian cattle, buffaloes and mules, for draught purposes, were discussed and the possibility of mechanical haulage gone into. The possibilities of the buffalo as a milk producer have not yet been appreciated in Trinidad, although in India the milch buffalo is the dairy animal *par excellence*. It was observed, however, that several well bred animals of the well known Marah or Delhi breed, have been imported from India, and they and their progeny were included in the herd.

After lunch, which was greatly appreciated, the party inspected the sugar factory, which, with a capacity of over 30,000 tons, is one of the largest in the British Empire, and were conducted round by Mr. Mayes, the Chief Engineer and Mr. W. Scott, the Sugar Technologist. Later a visit was paid to the dairy, which is in charge of Mr. Maclachlan. An up-to-date range of milking stalls have been put up, and the herd which is a mixed one, contains breeds of Zebu grade cattle, pure bred Holstein, and some Ayrshires imported direct from Canada. This dairy has been going less than two years, but some of the young stock, particularly the grade Holsteins, are showing good promise.

Mr. G. A. Jones, Agronomist to the Company, was good enough to explain a portion of his experimental programme, including the lime tests

which are resultant on the investigations carried out by the Froghopper Committee. He also pointed out his seedling canes and variety trials to the party, and it was particularly interesting to observe the progress of certain of the new Java varieties.

All those who attended are deeply grateful to Mr. Guy Westwood, General Manager of the Company, and to his staff for a most instructive and enjoyable day, and to Mrs. Westwood and the other ladies present for their very generous hospitality.

G. E.

MR. F. L. ENGLEDOW'S VISIT.

Mr. F. L. Engledow, M.A., of the School of Agriculture, Cambridge, has been commissioned by the Empire Marketing Board, after consultation with the Governing Body, to pay a visit of inspection to the Imperial College of Tropical Agriculture. His terms of reference are wide, but briefly he is to report on the general suitability of Trinidad for training in tropical agriculture, and suggest any changes in organisation that may be necessary in connection with the training of agricultural cadets. He will also enquire into the possibility of co-ordination with home Institutions, so far as the training of these officers is concerned. He is also to report on the research programme and the external relations of the College with any Research Institutions that may be associated with it. Finance will also engage his attention, and he will enquire into existing provisions and procedures, and make an estimate of future capital and recurrent needs. This gives a brief outline of the object of his visit, which is likely to lead to important results so far as the future policy of the College is concerned. Mr. Engledow arrived in Trinidad on 7th April by the s.s. *Ingoma* and is expected to leave on 3rd May. He will make his headquarters at the College, and will stay with the Principal.

WEST INDIAN SUGAR INDUSTRY.

We publish with this issue of *Tropical Agriculture* a Memoir by Professor C. Y. Shephard on "The Sugar Industry of the British West Indies and British Guiana with special reference to Trinidad," which has been reprinted from *Economic Geography*, April, 1929, Vol. V, No. 2. Non-subscribers to the Journal can obtain this Memoir (price 2*s*. per copy) on application to the Editor, Imperial College of Tropical Agriculture, Trinidad.

EXPERIMENTAL ERROR.

Dr. Maskell's article on "Experimental Error" which was concluded in the April issue of the Journal, can now be obtained on application to the Editor in the form of a special reprint. Price 1*s*.

OBITUARY.

We regret to have to announce the death at Moscow, on 17th January, of Dr. G. S. Zaitzev, Director of the Turkestan Plant Breeding Station. It was as a cotton geneticist and plant breeder that Dr. Zaitzev earned his world wide reputation. Appointed first as Chief of the Division of Plant Breeding at the Golodnostepskaya Agricultural Experiment Station in 1914 he eventually became Head of the Turkestan Plant Breeding Station in 1919. He also worked at the U.S.S.R. Institute of Applied Botany at Leningrad as cotton specialist and at the Central Asia State University as Professor of his subject.

COLWYN GOLD MEDAL.

We have received an advance copy of the new regulations for the Colwyn Gold Medal which is to be awarded in 1929 for the best essay (length, 5,000 words, with summary not exceeding 200 words) on the "Characteristics and Applications of Rubber." The essay must be submitted by a member of the Rubber Industry (of British nationality, but not necessarily a member of the Institution of the Rubber Industry) who has not completed his twenty-fifth year on the 1st January, 1929. Further particulars may be obtained from the Secretary, Institution of the Rubber Industry, Faraday House, 10, Charing Cross Road, London, W.C. 2.

COFFEE IN 1928.

The main feature of the coffee situation in the past year was the fact that the Brazilian Coffee Defence Institute retained complete control of the market in face of the production in Brazil for the 1927-28 season of the largest crop ever harvested. At the opening of the past season—that is on 1st July, 1927, interior stocks in Brazil under the control of the Institute amounted to 3,312,000 bags, and by the end of the season, 30th June, 1928, the figure had increased to 11,672,000 bags. By means of the financial assistance of the Institute the industry was able to hold this large surplus, and by regulating shipments from Brazil to accord with the requirements of consuming countries prices were maintained throughout last year at a level generally above that of 1927. Brazilian production for the 1927-28 season was 25,500,000 bags, and that of other countries 8,100,000 bags, making a total of 33,600,000 bags. Against this large supply there was a big increase in the world's consumption, which amounted to 23,500,000 bags, compared with 21,300,000 bags in the preceding twelve months. The crop now coming forward in Brazil is much smaller than the preceding one, and the interior stocks may be expected to show some reduction during the remainder of this season.—(*The Economist*, Vol. CVIII, No. 4, 459.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

Sugar.—The market has been generally quiet with very little business going on either in Raws or Refined, the chief factor responsible for the dull conditions being the continued limited interest shown by refiners in near-by shipments. Prices on the Home Markets have ranged as follows (*c.i.f.* per cwt.):

	Foreign.	*Preferential.*
	s. d.	*s. d.*
9th March	9 7½	13 1½
12th March	9 6	13 6
22nd March	9 4½	13 1½
27th March	9 3¾	13 0¾
3rd April	9 3	13 0
6th April	9 1½	12 10½

Cuba continues to dominate the market situation and its production has recently been estimated by Guma Mejer at the somewhat unexpected total of 5,218,428 tons, a figure which has been received by the trade with some surprise as there are many who think that such a production in Cuba is improbable.

* * *

Cotton.—American cotton quoted at 10.98*d.* on 21st March, has been in fair demand, quotations generally showing advances, until a sharp decline took place on 18th March. This was partly due to better weather in the South, but much more to the fact that it was commonly reported that the bull clique in New York was liquidating its longs, which brought in general selling from frightened weak holders, prices giving way sharply. Sea Island has been in improved demand, and more business has been done at steady rates.

* * *

Cocoa.—The London and Continental cocoa markets remain exceptionally dull and have been in quite a holiday mood before and since Easter. New York is in like condition and manufacturers have had no occasion to come into the market to buy in a general way. Advance advices of an exceptionally large Gold Coast crop have greatly influenced the situation, a factor, however, which should soon now have spent itself, as it is recognised that the estimate of 245,000 tons made by the American Trade Commissioner cannot possibly be reached.—(*By courtesy of Cocoa Planters' Association, Trinidad.*)

* * *

Coffee.—The demand for both London and Foreign Cleaned Costa Rica continues and prices have ruled steady. Practically all offers of Kenya were disposed of in auction at firm rates especially the fine bold sizes, where prices in some cases registered a slight advance. The *Times Trade and Engineering Supplement* states that sales per cwt. include, Jamaica at 210*s.*, Costa Rica at 155*s.*, Kenya at 130*s.* and Brazil at 105*s.*

* * *

Tea.—Budget rumours are not of much moment, but sales are a little impeded one way or another, so that this year to date only 862,000 packages have changed hands against 928,000 last year. Sales of Darjeeling for the season to date are 120,000 packages, against 108,500 last season, and Assam tea also shows slightly increased sales. The Java tea sales are rather small, but there is increased business in Sumatra. Latest averages comprise Ceylon, 20.92*d.*, Indian, 17.61*d.*, Java, 12.65*d.*, Sumatra, 15.63*d.*, Nyasaland, 13.78*d.* and Darjeeling, 22.90*d.* Japanese Oolong makes from 16*d.* to 36*d.*, according to quality.—(*Times Trade and Engineering Supplement*, 23rd March.)

* * *

Rubber.—Quotations for Plantation Sheet have ranged as follows: 8th March, 1*s.* 0⅝*d.*; 16th March, 1*s.*; 22nd March, 11*d.*; 25th March, 10⅞*d.*; 30th March, 11⅛*d.*; 6th April, 11*d.* The market has fluctuated rather frequently but only within narrow limits. Some disappointment was caused by the rather heavy Malayan shipments for February and a fair volume of speculative commitments was liquidated with, however, very little effect on the market, particularly as there was no particular evidence of trade buying. Another factor which has considerable bearing on the market is the question whether American manufacturers are at present over-manufacturing tyres and whether they may not find themselves stuck with large stocks later on. According to the *Times Trade and Engineering Supplement* (23rd March), consumption is increasing on both sides of the Atlantic and the market for futures reveals a certain amount of confidence in a continuance of the recent good demand from motor firms and vulcanizers.

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Copra.—The market is dull and West Indian *f.m.s.* is again lower at £23 10*s.* less ½ per cent. for April-May shipment.—(*West India Committee Circular*, 21st March.)

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Lime Products.—*Lime Oil:* Handpressed continues scarce and good quality is worth nominally 70*s.* per lb. Up to 32*s.* has been paid for Distilled on the spot and only small supplies are available. *Lime Juice:* Concentrated is unchanged at £25 *c.i.f.* or *ex wharf*, London. Raw has been in good demand with business done up to 4*s.* 1*d.* per gallon landed terms for good quality for shipment. — (*West India Committee Circular*).

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Bananas.—Jamaicas are in better demand and the price to wholesalers is higher at £20 per ton, delivered: the price to retailers is also higher at 10*d.* per dozen, carriage extra. Brazilians continue in good demand and are unchanged at £20 per ton delivered nearest railway station.—(*West India Committee Circular.*)